Electronic Data Collection for the Atlantic Access Point Angler Intercept Survey

Marine Recreational Information Program

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Project: ELECTRONIC DATA COLLECTION IN ATLANTIC COAST ACCESS POINT ANGLER INTERCEPT SURVEY

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Electronic Data Collection for the Atlantic Access Point Angler Intercept Survey

4. Acknowledgement

We would like to thank the Rhode Island and South Carolina field samplers for their efforts during the survey and all the feedback they provided.

5. Executive Summary

The overall objectives of this pilot study were to develop and field test a software and hardware system for data collection on electronic tablets during angler interviewing in the Access Point Angler Intercept Survey (APAIS) and that goal was largely achieved. The results were somewhat mixed but generally positive in regards to feasibility of the systems use in the field, cost benefits of implementing the system coast-wide, and in quality of data obtained vs. data quality resulting from paper form data collection, manual key-entry of data, and post-entry data quality controls currently in place in the APAIS.

However, there were several issues raised by both field staff using the test platforms and by the NMFS Principal Investigator about the utility and operational aspects of the developed application. The functionality of interviewing several anglers within a boat party simultaneously by switching among interviews, question by question, was a key attribute requested by field interviewers, but was not programmed into the app due to lack of flexibility in the software platform used. The logistic issues associated with handling fish (wet, slimy) and recording measurements continues to be a minor issue in handling and speed of interviewing. These impediments to rapid interview progress can deter anglers from interviewing and frequently led to some members of an angling party walking off, or refusing participation in the survey. These

issues were not typical deterrents to interviewing using paper and pencil. However, overall, the tablet data entry system is a vast improvement for data collection in the field and with software modifications and modernizations should prove to be cost efficient and a great time-saver in data acquisition, processing, and quality.

The objectives of flexible software that can be customized as needed among the Atlantic States (and ultimately all states using APAIS data collection), tablets being a useful hardware platform for APAIS data entry, and both time-saving and cost efficient data processing have all been met in this pilot study. The minor improvements recommended are not out of expectations in modern computer-based systems that are frequently upgraded to take advantage of improvements in both software and hardware development. We recommend implementation of tablet data collection for conduct of the MRIP Access Point Angler Intercept Survey.

Update - In January 2019 the Atlantic Coast Cooperative Statistics Program (ACCSP) implemented a proprietary application installed on Android OS tablets to directly collect APAIS data in the field. The 8 tablets were protected by glare screens and water-resistant, shock-resistant cases and the hardware-software system had been field tested by all the Atlantic states, ME to GA, under the administration of the ACCSPs APAIS program (survey conduct was transferred on the Atlantic Coast from a contractor to a cooperative venture between the NMFS, ACCSP, and the Atlantic States fisheries resource management agencies in Jan. 2016). Through the first year of use, the tablets have been durable (one broken, none failed) and the software has proven adaptable to requests for improvements in survey flow and questionnaire modifications. There are no subscription fees to the developers who have been maintained on open-contract by ACCSP for this and other applications maintenance and development. Data transmittal and integrity has been flawless with the only problems traced to operator error. The Gulf of Mexico regions GulfFIN program procured funds to develop a similar application for their use, intend to use the same software developers, and implement tablet data collection for the APAIS in FL, AL, and MS in January 2021 pending successful testing of their new system in fall, 2020.

6. Background

Background and Objectives

The National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS, NOAA Fisheries) recently approved a policy regarding the adoption of electronic technology solutions in fishery-dependent data collection programs. This policy states:

It is the policy of the National Oceanic & Atmospheric Administrations (NOAAs) National Marine Fisheries Service (NOAA Fisheries) to encourage the consideration of electronic technologies to complement and/or improve existing fishery-dependent data collection programs to achieve the most cost-effective and sustainable approach that ensures alignment of management goals, funding sources and regulations.

The policy requires each region, Alaska, Greater Atlantic, Pacific Islands, Southeast and Caribbean, and West Coast, to evaluate the application of electronic technologies to fisheries management within their areas of responsibility. Implementation of this objective requires contract support to oversee and facilitate this agency-wide effort in conjunction with the Regional Fishery Management Councils, Interstate Fishery Commissions, and other stakeholders.

Under contract with NOAA Fisheries, RTI International (RTI) conducted the paper and pencil interview (PAPI)-based Atlantic Access Point Angler Intercept Survey (APAIS) in the thirteen Atlantic coastal states north of Florida from 2012 through 2015. In 2014, RTIs contract expanded to include work in Puerto Rico; this work is ongoing. NOAA Fisheries also contracted with RTI to test the feasibility of electronic tablet-based data collection on the APAIS in the summer and fall of 2015. This work was designed to examine the benefits and challenges associated with operating in marine coastal environments. RTI managed the development, field testing, and implementation of data collection using Samsung Galaxy 4 tablets and RTIs Mobile Field Surveys (Mobile FS) software. The implementation was conducted in Rhode Island and South Carolina using APAIS staff who were familiar with the PAPI survey operation. The field test was conducted August 1st through November 30th, 2015, subsequent to development and field testing.

Objectives

1. Develop software that is adaptable for use in 15 states with flexible questionnaires suitable for use on a tablet.

2. Demonstrate that APAIS intercept survey data can be successfully collected using a tablet under typical field conditions.

3. Increase efficiency in the overall process of collecting and entering data, and evaluate cost savings by eliminating data forms, and hand-data entry staff or OCR hardware/software, while providing seamless integration of data into existing data processing algorithms and schedules.

4. Improve data accuracy via internal data limits and checks at point of entry and QC oversight of field interviewers' activity by automatically recording GPS locations, dates, and times of survey conduct.

5. Provide near real-time data access for survey data users.

A secondary goal of the project was to evaluate the impact of tablet use on productivity of the APAIS by comparing catch estimates generated from each method. This evaluation would take into account the catch composition of the samples, the productivity of interviews obtained per sampling assignment, and the variance of the catch estimates produced from the tablet samples vs the PAPI samples during the same wave. This goal required additional staff support from NMFS/ST1 outside the project team.

7. Methods

<u>Methodology</u>

RTI developed the electronic field survey using RTI Mobile FS, a powerful platform that allows users to conduct field studies on Android mobile devices. RTI Mobile FS is a suite of tools used to develop questionnaires for the iPAQ (Windows Mobile), Android and PC/Windows platforms. The suite includes tools for developing questionnaires, changing file formats, updating system options, and creating import files. The system also includes components for data management which allow a user to aggregate data, run reports, export data, and create SAS, SPSS, or Stata input statements for data collected with the system. The standard APAIS paper forms were replicated into the Mobile FS application using the same structure and language as it appears on the form.

RTI selected Mobile FS for the project as it was the most cost-effective and field-ready tool with respect to a budget that encompassed development, testing, data collection, and data management. The request from NMFS was a custom built application that would allow use of the APAIS interview in a similar appearance to the paper form (question followed by check boxes for response choices, or fields for character entry if open response or codes required) and the flexibility to switch among interviews without loss of partially completed interview data. Many off the rack applications could develop the first requirement but the easy switch among partially completed forms was difficult to design and operate efficiently. That lesson was learned by the earlier trials of software/hardware by Macro International, a previous Atlantic Coast APAIS

contractor.

Hardware

The Mobile FS APAIS Data Collection System was deployed on a Samsung Galaxy Tab 4 (Model SM-T230) tablet using Android Version 4.4.2. This device was selected due to its cost, size, weight and performance. The Tab 4 weighs only 1.4 pounds and has a 7-inch screen size, ideal for ease of handling for the duration of a six hour assignment. Ten (10) total tablets were purchased: four were deployed in each state, and two were retained by RTI for testing and troubleshooting. Protective covers were purchased to protect the device from environmental hazards and proved to be an ideal accessory for this purpose. The cover was a SUPCASE Unicorn Beetle PRO case (Model: SUP-GalaxyTab4-7-UBPRO-WHGY). These cases provided a high grade polycarbonate case for shock absorption, and a front cover with screen protector to prevent scratches while maintaining touch screen sensitivity. The cases were not water proof, but the dual layer design provided water resistance. No tablets were destroyed during the study due to water intrusion or damage from drops. Interviewers were also provided with a Samsung 2Amp Micro-USB Vehicle Charger (Model: ECA-U21CBEBXAR) to enable mobile charging from their vehicle.

Software

Mobile FS is a native Android application and supports deployment to Android OS versions 4.0 and above. SQLite is used for data storage, and all survey related data is encrypted at rest and synchronized back to the private RTI network via a secure (HTTPS) communication channel.

RTI has developed and delivered the following components to the NMFS:

All hardware purchased for the pilot project

the ANDROID APAIS Mobile application installation file - APAIS.APK

gats_survey0.db3 database that houses the Assignment Summary Form Survey

gats_survey1.db3 database that houses the Intercept Form Survey

gats_CMSDB.dbe database that houses the application configuration and assignment data

The APAIS.APK is a binary executable that can be installed onto an ANDROID device by copying it to the device and executing. The db3 files can be accessed and manipulated with open source tools such as SQL Lite. New question and answer sets can be added to a survey by adding the information into the appropriate db3 file.

Software Architecture

Four major components were developed for the APAIS mobile application: the Case Management System (CMS), a two tiered main menu, Assignment Summary Form, and Intercept Form. Upon initiating the application on the tablet the main CMS screen appears along with informational items: system version, current date and time, and a password entry prompt for logging in. Note: the demo tablet/software includes a Set Clock button on this initial screen but if this is operational by field staff it could allow for editing of time by unscrupulous interviewers who arrive late but wish to code the data with the scheduled arrival time this function should be removed and allow the device to capture the date/time from the service provider, GPS, or fixed by admin only.

The CMS provides the framework for the APAIS Mobile application to operate and is password protected via a Login button. In this application a single case is an APAIS sampling assignment, identified by date, interval, mode, site(s) with state-specific control numbers (provided by the contractor; not the control7 produced by the NMFS assignment draw). Each case would then include a single Assignment Summary Form (ASF) and multiple interview forms (or none if no interviews were obtained.

Upon logging into the application, the case menu displays open assignments to the user. At this point the user has the ability to open the intercept form or the Assignment Summary Form for any of the available assignments to begin collecting data. The user can move between these

two options within each assignment by returning to the Main Menu.

Case ID numbers are color-coded, allowing the user quick identification of opened cases. Several variables are preloaded from the assignment draw, including assignment date, mode, time interval (6 hour assignment interval), site numbers (single or two-site clusters), and control number. These variables are essential to help interviewers stay organized and working at correct times and locations. Submenus are also available from the main menu allowing the user to select various options; Action, Admin, and View.

The Action option presents the user with a menu that provides the option to Transmit. This action starts the secure wireless connection to the IFMS (Integrated Field Management System) at RTI and uploads all data collected while on assignment. The transmission process also downloads new assignments for the user and any available system updates. A confirmation message is displayed at the conclusion of the transmission process to confirm transmission was successful. If instrument updates are sent to the device by the IFMS, the CMS detects the update file and prompts the user to accept and proceed.

The View option allows the user to sort the case menu by cases that are Pending meaning the cases that have been started but have not been completed in the Assignment Summary Form. This aids the user in verifying the status of their assignments.

The Sort option allows the user to sort their case menu by case ID, event code, assignment date, control number, or county. This feature allows the user to customize the case menu in the manner that is most useful to them and to minimize the time it takes to locate the desired case.

1. Intercept Form

The intercept form is accessed from the main menu. Each intercept has a predefined unique case ID. The user selects the desired intercept and the form opens with prefilled information from the draw such as intercept number, state code, county code, etc. The user is immediately prompted to start the GPS capture, and an automated satellite request is sent for a GPS location that is stored with the intercept.

Predefined list options are presented where possible, allowing the user to tap selections to expedite data entry.

Incremental seek options are provided to the user when the response requires an open entry (typed characters) such as the state and county of residence, or fish species targeted, caught (reported) or landed and examined. The user enters the first few characters, the associated entries fill a list, and the user selects and confirms the response choice.

When the user is weighing and measuring a fish, they are presented with the option to take a photo of the fish. The photo filename matches the case ID, and filenames update sequentially as additional photos are added.

Intercept skip logic was programmed into the application, meaning questions not to be asked due to the response of a previous question are not displayed. However, if the response to the earlier question requires a subsequent question be asked, all the questions are displayed and a response is required to complete the interview. An example is the area fished questions: if area fished response is Ocean, then distance from Shore must be asked; if area fished is any of the Inland bodies (e.g. river, bay, specific estuary) the distance from shore choice is not displayed.

Additionally, a CARI (Computer Audio-Recorded Interview) feature was implemented in the final month of the pilot. This feature was discussed as a possible use of the hardware features, but was not specifically requested by the NMFS.

2.   Assignment Summary Form

The Assignment Summary Form is also accessed from the main menu. As with the intercept form, data items such as control number, state code, county code, and mode are pre-loaded, negating the need to enter them and expediting the data entry process. Other items are programmed in defined lists, allowing the user to tap the appropriate choice and further reducing potential data key-entry errors.

3.   Case Completion and Data Transmission

Numerous data validations are built into the logic to help users identify possible data entry errors and/or prevent incompatible responses to correlated questions, or invalid responses to any question. A simple example is the start and stop times for a site. The stop time must be after the

start time. If it is not, an error message appears prompting the user to correct the entry.

When the user is ready to complete an assignment, they sign off by entering their interviewer ID into the last screen of the Assignment Summary Form. Once this is entered, the case is coded as complete and disappears from the Main Menu. The data is transmitted during the field interviewers next transmission session.

Field Assignments for Application Testing

NOAA Fisheries supplied the assignment sample draw on a monthly basis for the four months of field testing, August through November 2015. The pilot was conducted in Rhode Island with RTI managed field staff and in South Carolina with SC Department of Natural Resources staff. All staff members also conducted the standard APAIS study during the time period of the electronic tablet pilot. Field staff varied in age and technology aptitude offering a diverse group of opinions on the tablet functionality.

Assignments were drawn within a specific assignment mode per month targeting anglers only fishing from unique access points (SH = Shore, MB = Mixed Boat Private, Rental and Charter boats). Below are the number of assignments drawn in each state by mode and month:

Table 1. Tablet Pilot Assignments

8. Results

1. <u>Results</u>

RTI and NMFS analyzed the results of the tablet data collection for numerous metrics, including production, costs, timeliness, error rate, added benefits, and catch estimation. These five variables are discussed in detail below.

a.   **Production**

To analyze the performance of the tablet in the field compared to the paper form we calculated Percent Intercepts Collected (PIC). We calculated PIC to help quantify whether the tablet was keeping pace with the paper forms in terms of total interviews collected as a proportion of total eligible anglers.

PIC =   Total Intercepts Collected / (Total Intercepts Collected + Total Angler Counts)

Total angler counts refers to all eligible anglers that were not interviewed during the six hour interval, including initial refusals, confirmed and unconfirmed trip counts, language barriers and key question refusals. Ineligible anglers (commercial, targeting shellfish, etc.) were not included in the Total Angler Counts variable.

The PIC was calculated based on mode and state. Overall, the tablet seems to struggle with collecting boat mode intercepts, but does relatively well with shore based anglers. We anticipated a drop in the mixed boat production, but did not expect such a dramatic decline for both Rhode Island and South Carolina.

Table 2. Tablet vs Paper Productivity: Mode Comparison

To help compare the tablet and the paper forms more fairly, we wanted to compare only assignments that were conducted in the same mode, wave and time interval combinations. Out of 34 potential combinations, only 13 had both a tablet and paper assignments completed.

Table 3. Unique Assignment Combination Productivity

Again, many factors contribute to the ability of an interviewer to gain an intercept, but when normalizing for mode, wave and interval, we see that the tablet does very well at keeping pace with the paper forms. The tablet outperformed the paper forms in terms of PIC in Rhode Island and South Carolina on roughly 30% of assignment combinations. The tablet did struggle in mixed boat mode in some assignment combinations, but the paper forms did not do exceptionally well in those same sample cells. The tablet works very well in shore mode assignments because survey protocols dictate that shore mode anglers must be interviewed individually. If the survey were to be redesigned to a boat-based survey, rather than an individual angler survey, we believe the tablet would outperform the paper form in terms of productivity relative to PIC.

b.   Cost

The cost of Android tablets has decreased significantly in the past few years and continues to decline. For this project we purchased Samsung Galaxy Tab 4s, a sturdy protective case and mobile charger all from Amazon.com. Table 4 outlines total cost for materials.

Table 4. Upfront tablet costs

Field costs are fixed in both the tablet and paper studies because the interviewers must travel to the site(s) and conduct interviews over the full six-hour interval. Development/programming costs are also negligibly different for each survey method because there is comparable level of effort to produce a functional data entry system whether it is Android-based or PC-based. The true cost savings are recognized in the data entry costs.

Tablet data collection transferred the burden of data entry from the Raleigh, NC-based APAIS team to the interviewers in the field. The APAIS contract mandates a Service Contract Act (SCA) wage for hourly employees, which is set at $12.97 per hour for a Data Entry Operator in Wake County, NC. The average time to key a paper APAIS assignment was 15 minutes with high levels of variability depending on the number of intercepts collected. Knowing these inputs, we could calculate the cost-savings associated with the completed tablet assignments.

We recognized a cost savings of $651.74 over the four months of the pilot by completing 201 assignments on the tablet rather than manually keying the data. However, the tablet assignment quotas were less than the normal assignment quota for the main study. If the tablet were to be used in only Rhode Island and South Carolina to complete the main study, the upfront costs of the tablet would almost be recouped after just four months.

Keeping all other costs fixed, use of tablets to administer the APAIS between August and November in Rhode Island and South Carolina would save $1548.26. Rhode Island (756) and South Carolina (378) completed a total of 1,134 shore and mixed boat assignments in 2015; if all 1,134 assignments were completed on the tablet application, $3,677 would be saved in data entry costs easily covering the upfront hardware costs in the first year and earning an additional $1,693.80 in savings.

Reduction in printing costs would also be realized as tablets completely replace the need to print paper forms. During the pilot, 231 total assignments were completed comprising 945 intercepts. This translates to a total of $59.01 in savings of printing costs. While not a notable value for the pilot study, extrapolating to encompass the more than 50,000 intercepts and 7,000 assignments completed each year yields significant cost savings.

It should be noted that tablet costs have declined even further in the time since hardware was purchased for this project. The same tablets are now selling for $129.00 on Amazon.com, further reducing the upfront costs by $360 for the same 10 tablets. As technology continues to advance and becomes more affordable, the tablet solution will generate more and more savings to the APAIS project.

c.   Timeliness

Faster availability of fisheries data is an additional priority addressed through electronic data collection. The pilot investigated improvement in data timeliness for data collected with the tablet versus paper forms. For the standard paper survey, it takes on average 17 days from assignment completion in the field until it is first keyed into the database. This delay is the result of many factors including staff-delayed shipping, transit delays, and processing procedures (i.e. assignments with intercepts are prioritized to be key entered first and single ASFs are keyed second). Data prioritization is essential to meet the project timeline of having all available biological data available for review on the 10th of the following month in Fishdump. Fishdump is a listing of all the raw fish data (species, counts, lengths, weights and dispositions) along with

associated angler-trip attributes (gear, mode, available vs unavailable catch) to visually scan for obvious coding or key-entry errors prior to delivery of data to the NMFS. As expected, the tablet performed much better in terms of timeliness with a zero day average between assignment completion and data being transmitted into the database. There were initial programming costs associated with getting the data into the correct format from the Mobile FS data scheme to the APAIS database format, but once that process was established and tested, the data came in seamlessly.

d.   Errors

Error rates were very similar between the tablet assignments and paper assignments. We calculated the rate of INTCHCK (the APAIS error checking SAS program) errors between the two modes and found that they were relatively equal at about .02 errors per assignment. However, this error rate could be close to zero on the tablets with additional programming. After training sessions with the staff in Rhode Island and South Carolina, we immediately received feedback that they did not want any hard stops for invalid entries or range checks to confirm entry. Field staff were concerned that the tablet would already be slower than a paper form and they did not want any additional steps that would force them to stop and correct data in the middle of an interview. As such, we programmed the tablet with minimal range checks and allowed field staff to scroll back through all data prior to transmitting to RTI. Additional programming could allow more hard stops and on the fly validations once the staff were comfortable enough with the tablet and work flow.

e.   Added Benefits

i.   Photographs

One advantage of the tablet is the ability to capture photos of fish on the built in 3.0 megapixel camera and transmitting the photo with the assignment data. The photo allows quick confirmation of questionable species or lengths (if size reference included in photo). Currently, the best method for questioning species, lengths, and weights is during monthly data reviews and relies on sampler recall or individual initiatives to bring digital camera on field assignments.

Photo 1. Atlantic Mackerel from Rhode Island

ii. GPS

Built in Global Positioning System (GPS) technology in the tablet recorded latitude and longitude while in the field to confirm location of samplers while on assignment. This was not an active GPS that allowed RTI staff to monitor the samplers every movement, but a passive GPS that could be recorded when convenient for the sampler. The GPS capture screen appeared in each intercept as well as the Assignment Summary Form. Location data was particularly helpful when an invalid site error occurred in South Carolina. The sampler had accidentally entered the wrong site code for the assignment, producing an error when validating the data after he transmitted. The sampled had captured a GPS ping when he was on site and it was confirmed he was at the correct site by comparing the latitude and longitude data from the assignment to the Site Register data. This feature can also be used in background (admin controls only) to record positional data periodically during a pre-programmed period to document where and when the operator (interviewer) was entering interview data.

f.   Catch Estimates *This secondary goal resulted in more staff resources required than originally anticipated given the complexity of the MRIP estimation methodology and combinations with all other required components from effort surveys. Therefore, it was tabled indefinitely (as of this report this task was not completed). There is no reason to suspect the tablet entry of the APAIS interview responses would in any way influence the outcome of the estimates because the interview is identical to the paper form interview. The productivity and possibly biased samples used in this pilot study are more likely to result in different cpue estimates than those produced from the full APAIS samples completed in both RI and SC during the pilot waves. See the discussion below of the tablet productivity vs the paper form productivity and possible reasons for the differences.*

9. Limitations

<u>**Critique by RTI Team members**</u>:

The pilot project was not without its challenges. RTI did overcome obstacles and received helpful feedback from the field during the pilot. Below are a few of the challenges that occurred during the pilot, which should be considered in future development.

1.   Version control in the field Throughout the pilot, RTI was receiving feedback from the field about programming glitches or recommendations for improvements. For example, the type 2 catch grid was developed as a loop function that was not allowing samplers to get out of the grid. When RTI was made aware of the issue, we quickly developed a fix and rolled it out to the field through their next transmission. We made everyone aware of the update, provided instructions on how to install and asked for any feedback if it did not work. When we didnt hear any communication from the field, we assumed that the installation went as planned. That assumption turned out to be incorrect. We had samplers in the field that were frustrated because their install did not work properly and they continued to struggle with problems that should have been fixed with latest update. Once we found out that the updates were not installing correctly, we adjusted our installation instructions to include how to verify the correct version of the program was installed. That helped alleviate the issue of proper version control and we were able to quickly identify any samplers and tablets that needed direct support. Communication is essential to and from the field, and building a communication plan into the project schedule will help ensure success in future deployments.

2.   Overcoming perceptions Change is always difficult and an instrument change is especially difficult to implement in the survey world. The tablet was initially received very poorly by a few field members because it felt slow and eliminated many of the shortcuts they were able to utilize on the paper form. When doing field visits with the tablet, a sampler said, [The tablet] makes me look stupid. The sampler was referring to the perception that the tablet was taking too long to complete an interview. Immediately after this, an intercept was completed in under a 60 seconds; however, there were no type 3 fish to weigh and measure. There was a perception in the field that the tablet was just not as efficient as the paper form, but we believe with a few procedural and instrument adjustments the negative attitude could be improved.

3.   Productivity of Tablet vs Paper Form Interviewing - There are numerous factors that can help explain the apparent drop in production when the tablets were used to record interview responses. First, the assignment intervals were not kept constant with the paper study. The

sample draws were produced step wise, meaning that the sample for the main paper study was produced first and then the tablet assignments were drawn from the remaining available sample cells. This method shifted numerous tablet assignments to less productive intervals (B/C) and day types (weekdays). The lack of peak interval weekend assignments helps explain the decline in intercepts per assignment. Second, when field samplers are interviewing groups of anglers off a single boat on the paper form, they often employ shortcuts to help maximize the number of intercepts collected. The most common shortcut observed in the field is recording multiple responses on a single form in available white space, and then transcribing those responses later on their own individual forms. Although this is not how the form was designed to be used, it is a common practice in the field. The tablet does not allow such shortcuts and forces the interviewer to go angler by angler to complete the intercept form. When intercepting large boat parties, the tablet often only produced one or two interviews, but the paper form often allowed interviewers to squeeze 5 or 6 interviews from a large fishing party. This also likely explains why the tablet appears to perform much worse in mixed boat mode assignments as compared to shore mode.

4.   Fish slime The largest drawback witnessed in the field was the ability to process a large cooler of fish in the type 3 catch grid quickly. Handling numerous fish one after another causes slime build up on the samplers hands and tablet. Even with constant toweling off and wiping, the tablet was very sensitive to the buildup of slime on the touch screen often causing taps and swipes to be unrecognizable. An assignment was observed when two angles returned to a ramp with a total of 100 fish in a cooler (50 fish per day limit). The sampler was able to get through about 10 total fish before the tablet started not recognizing taps and swipes causing sampler frustration. Normal survey procedures dictate that no more than 15 of each species per angler (30 total in this example) should be weighed and measured and all grouped catch should go on the first angler of the party. The sampler was unable to get to the 30 spot for this fishing party due to the quick buildup of slime on the tablet. Again, with further procedural and tablet adjustments, there may be a more efficient way to collect the type 3 data with minimal frustrations.

5.   Computer Audio Recorded Interview (CARI) Technology During the pilot, RTI distributed an update to the tablet that allowed samplers to record interviews with respondents. The respondents were made aware of the recording at the beginning of the interview and had the ability to decline the recording while still granting an interview. This technology was met with extreme disdain from a few members of the field sampling team and production was not as high as we would have hoped. We are unable to directly link the lack of recorded interviews to a procedural issue or a general refusal from the recreational anglers. There could be public

perception from the fishing community that the survey is not only invading on their recreational activity, but is doing so even more by now recording these conversations. Although explanatory language was added into the interviewing script that the recording was used for quality control purposes only, we believe there was general mistrust from the public regarding recorded interviews. This may be the level at which recreational anglers protect their information or it could just be reflective of the current level of trust citizens have with any perceived authority.

For the interviews that did transmit, most were extremely clear and we were able to clearly here the question being asked by the sampler and the response from the angler. This could be an extremely valuable quality control measure moving forward by allowing supervisors to remotely listen to how questions are being asked in the field and verifying that information with the transmitted data. Not all interviews were able to be heard clearly as wind seemed to muffle the microphone and completely mask the conversation between the sampler and angler on more than one occasion. Of the 17 audio recordings that were transmitted from the tablets, 14 came in with clear, understandable audio content. We believe that this tool can be successfully rolled out in the APAIS survey and would cut down on travel time and costs associated with field observations.

Critique by NMFS PI

Software one overall objective was to develop software that could be used for Atlantic Coast states with the flexibility to be customized by state, if needed. The intercept form in this app is flexible to the extent that questions can be added/dropped or tailored to an individual state, or cluster of states, or all states. But the overall architecture of the app is not entirely as envisioned by the NMFS. The Case Management System is clearly an available survey structure RTI had in-house. Note the description of the software system by RTI staff (above, in Results): RTI selected Mobile FS for the project as it was the most cost-effective and field-ready tool with respect to a budget that encompassed development, testing, data collection, and data management. From conversations with RTI staff there apparently was a disconnect with the system and software requirements during the project cost proposal preparation between project (survey) staff and the software development team that provided the cost estimate for software development. Once the project was approved and funded, when the programmers met with the project staff and specs were provided the programmers realized the requested software was more complex than they had originally understood but could not be completed within the funded

budget. Therefore, the Mobile FS and CMS was adapted for use by the APAIS tablet pilot, which restricted several key attributes requested by NMFS. These were the easy transition among, or multiple angler interviews open, anglers within a boat party which would allow simultaneous interviewing, a practice on paper forms common by making notes in the margins for other anglers who were in the same party as the interviewed angler, then transcribing onto forms later. Another shortcoming of this app is the lack of linkage between the ASF and Interviews. The Interviews can be started directly from case identifier in the main menu, but should be a subset of the required ASF. Every assignment must have an ASF regardless of interviews obtained, or not. And, the ASF linkage should allow cross identification of site and times of interview(s), as well as prepopulating the date of the assignment to ensure the ASF and interviews are correctly referenced in the data files to be delivered to NMFS.   Although these are all software features that could be corrected in future versions, as RTI discussed above, the lack of inclusion in the field trial prevented field staff from testing the efficiency of a fully functioning app as originally intended.

10. Discussion/Conclusions/Recommendations

5.   Discussion

We feel that electronic data collection would be extremely beneficial to the APAIS project and should continue to be pursued for full implementation. The improvement in data timeliness is an incredible advantage of mobile data collection and a huge benefit for managers and scientists looking for more real time data from the recreational sector. Cost savings are quick to be realized even with upfront costs associated with hardware purchases. The ability to control and limit errors was not fully utilized in the pilot due to field concerns, but the potential to continually improve data quality still exists through the use of photos and GPS. This pilot project proves that the ability exists to transform the APAIS survey from a paper data collection instrument to a tablet based survey, and there are numerous benefits to be gained in doing so.

The 17 day improvement associated with the tablet data being entered, transmitted, and compiled into a data base on a daily basis could be a game-changer for fisheries management and data review. Data being available for review on a weekly or even daily schedule could greatly improve in-season monitoring by allowing harvest estimates to be produced more frequently given some improvement in modeling or estimating effort to be associated with the catch-rate data. For true estimates to be produced in near-real time improvements to the entire suite of MRIP surveys would need to be made, but having the APAIS data available much more quickly is a great starting point.

6. Next steps

RTI believes the next appropriate step is to roll out the electronic data technology for full field implementation of the APAIS survey. With further adjustments to the instrument, the tablet can become even more streamlined and user friendly. One sampler said, I wish the tablet would learn, meaning that customized lists of angler responses that allow faster data entry in the field would be well received. The benefits and cost savings greatly outweigh the upfront technology costs associated with the tablets. There was a limited budget to program the instrument and cover all field costs, but we believe with additional funding to improve the tablet program and address any survey procedural adjustments, this program could pave the way for electronic data capture from the recreational industry.

Although this application would be sufficient to implement tablet data entry in the field for the APAIS program, it would require upgrades to several key aspects to be as efficient at obtaining angler interviews from many or all anglers per boat party as paper forms allow. The slow, serial interviewing was an impediment to obtaining some interviews with anglers walking away rather than waiting their turn. The lack of linking and sequential entry of ASF and angler interview is a data quality concern of NMFS, and in its present form that task can be accomplished post-entry, but as stated earlier in this report, if data can be verified or checked for errors in the field at point of entry, the quality would be superior, and any corrections could be made immediately and much more efficiently (less time, virtually no investigative cost).

This pilot study did support the major objectives of developing an adequate software/hardware system suitable for use in APAIS field interviewing. It provided data in an extremely timely manner (possibly daily with daily transmission from field), was very cost effective in reducing manpower costs of data entry and reducing post-entry processing costs, provided seamless compilation of data from many interviewers once protocols programmed, and proved to stand up to typical field conditions without major problems of durability. The handling of fish and data entry continues to be time-consuming, but technology may soon provide digital measuring and weighing devices that transmit the output via Bluetooth to the tablet, thus eliminating the handling of fish and tablet sequentially.

The overall recommendation is to implement the use of an electronic tablet system as a tool for field data collection during angler interviewing. The tablets used are one model but there is no reason to suspect comparable hardware with similar attributes and capabilities would prove less hardy and useful. The software system needs improvements and given the interest in producing such apps, and those already available, or in development by cooperating contractors and agencies, suitable alternatives could be chosen for implementation. It is conceivable that multiple apps may be used along the coast provided each app output the data in a format that could easily be transcribed into a common database for delivery to NMFS and use in MRIP estimation of catch and effort statistics.

11. References

SEFSC

12. Comments

Add section to Exectuvie Summary describing current status/implementation

13. Appendix

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Electronic Data Collection for the Atlantic Access Point Angler Intercept Survey
RTI International

Executive Summary – *to be written with NMFS*

Background and Objectives

The National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS, NOAA Fisheries) recently approved a policy regarding the adoption of electronic technology solutions in fishery-dependent data collection programs. This policy states:

"*It is the policy of the National Oceanic & Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NOAA Fisheries) to encourage the consideration of electronic technologies to complement and/or improve existing fishery-dependent data collection programs to achieve the most cost-effective and sustainable approach that ensures alignment of management goals, funding sources and regulations.*"

The policy requires each region, Alaska, Greater Atlantic, Pacific Islands, Southeast and Caribbean, and West Coast, to evaluate the application of electronic technologies to fisheries management within their areas of responsibility. Implementation of this objective requires contract support to oversee and facilitate this agency-wide effort in conjunction with the Regional Fishery Management Councils, Interstate Fishery Commissions, and other stakeholders.

Under contract with NOAA Fisheries, RTI International (RTI) conducted the paper and pencil interview (PAPI)-based Atlantic Access Point Angler Intercept Survey (APAIS) in the thirteen Atlantic coastal states north of Florida from 2012 through 2015. In 2014, RTI's contract expanded to include work in Puerto Rico; this work is ongoing. NOAA Fisheries also contracted with RTI to test the feasibility of electronic tablet-based data collection on the APAIS in the summer and fall of 2015. This work was designed to examine the benefits and challenges associated with operating in marine coastal environments. RTI managed the development, field testing, and implementation of data collection using Samsung Galaxy 4 tablets and RTI's Mobile Field Surveys (Mobile FS) software. The implementation was conducted in Rhode Island and South Carolina using APAIS staff who were familiar with the PAPI survey operation. The field test was conducted August 1st through November 30th, 2015, subsequent to development and field testing.

The goal of the project was to determine feasibility of using tablet versus PAPI administration of the APAIS by comparing catch estimates generated from each method. The project also allowed the team to compare additional performance metrics including hardware logistics, cost, data timeliness, and other production considerations.

Methodology

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RTI developed the electronic field survey using RTI Mobile FS, a powerful platform that allows users to conduct field studies on Android mobile devices. RTI Mobile FS is a suite of tools used to develop questionnaires for the iPAQ (Windows Mobile), Android and PC/Windows platforms. The suite includes tools for developing questionnaires, changing file formats, updating system options, and creating import files. The system also includes components for data management which allow a user to aggregate data, run reports, export data, and create SAS, SPSS, or Stata input statements for data collected with the system. The standard APAIS paper forms were replicated into the Mobile FS application using the same structure and language as it appears on the form.

RTI selected Mobile FS for the project as it was the most cost-effective and field-ready tool with respect to a budget that encompassed development, testing, data collection, and data management. Mobile FS has been very effective with intercept-based projects in the past, including the Global Adult Tobacco Survey, Nigeria Education Data Survey and Global Network for Women's and Children's Health Research.

Hardware

The Mobile FS APAIS Data Collection System was deployed on a Samsung Galaxy Tab 4 (Model SM-T230) tablet using Android Version 4.4.2. This device was selected due to its cost, size, weight and performance. The Tab 4 weighs only 1.4 pounds and has a 7-inch screen size, ideal for ease of handling for the duration of a six hour assignment. Ten (10) total tablets were purchased: four were deployed in each state, and two were retained by RTI for testing and troubleshooting. Protective covers were purchased to protect the device from environmental hazards and proved to be an ideal accessory for this purpose. The cover was a SUPCASE Unicorn Beetle PRO case (Model: SUP-GalaxyTab4-7-UBPRO-WHGY). These cases provided a high grade polycarbonate case for shock absorption, and a front cover with screen protector to prevent scratches while maintaining touch screen sensitivity. The cases were not water proof, but the dual layer design provided water resistance. No tablets were destroyed during the study due to water intrusion or damage from drops. Interviewers were also provided with a Samsung 2Amp Micro-USB Vehicle Charger (Model: ECA-U21CBEBXAR) to enable mobile charging from their vehicle.

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Figure 1. Samsung Galaxy Tab 4

Figure 2. Unicorn Beetle Case empty (left) and covering Tab 4 (right).

<u>Software</u>

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Mobile FS is a native Android application and supports deployment to Android OS versions 4.0 and above. SQLite is used for data storage, and all survey related data is encrypted at rest and synchronized back to the private RTI network via a secure (HTTPS) communication channel.

RTI has developed and delivered the following components to the NMFS:

- All hardware purchased for the pilot project
- the ANDROID APAIS Mobile application installation file - APAIS.APK
- gats_survey0.db3 – database that houses the Assignment Summary Form Survey
- gats_survey1.db3 – database that houses the Intercept Form Survey
- gats_CMSDB.dbe – database that houses the application configuration and assignment data

The APAIS.APK is a binary executable that can be installed onto an ANDROID device by copying it to the device and executing. The db3 files can be accessed and manipulated with open source tools such as SQL Lite. New question and answer sets can be added to a survey by adding the information into the appropriate db3 file.

Four major components were developed for the APAIS mobile application: the Case Management System (CMS), a two tiered main menu, Assignment Summary Form, and Intercept Form. The four components are detailed below.

1. **Case Management System**

The CMS (Case Management System) provides the framework for the APAIS Mobile application to operate and is password protected. Informational items appear on the initial screen such as system version, current date and time, etc.
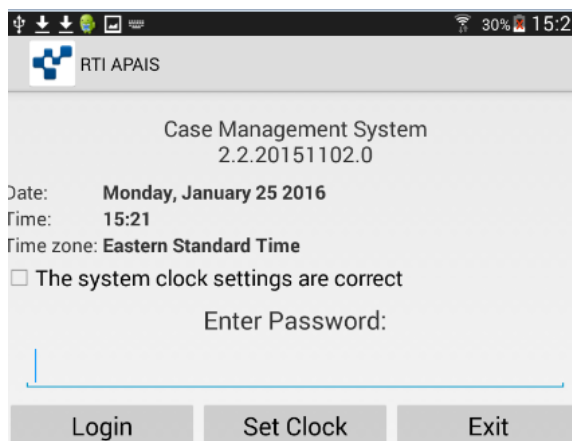
Figure 3. Case Management System Initial Screen

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Upon opening the application, a case menu displays open assignments to the user. At this point the user has the ability to open the intercept form or the Assignment Summary Form for any of the available assignments to begin collecting data. The user can move between these two options within each assignment by returning to the Main Menu.

2. Main Menu
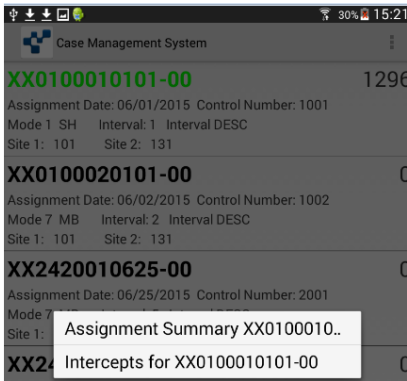
Figure 4. Two-Tiered Main Menu

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Figure 5. Assignment Summary Menu

Case ID numbers are color-coded, allowing the user quick identification of opened cases. Several variables are preloaded from the assignment draw (Figure 4),including assignment date, control number (unique identifier), mode (1 for Shore mode, 7 for Mixed Boat mode), time interval (6 hour assignment interval) and site numbers (single or two-site clusters). These variables are essential to help interviewers stay organized and working at correct times and locations. Submenus are also available from the main menu allowing the user to select various options; Action, Admin, and View.

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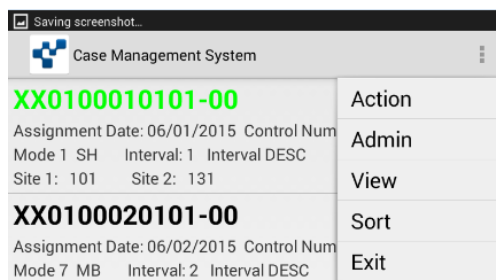
Figure 6. Case Management System Submenu

The Action option presents the user with a menu that provides the option to 'Transmit'. This action starts the secure wireless connection to the IFMS (Integrated Field Management System) at RTI and uploads all data collected while on assignment. The transmission process also downloads new assignments for the user and any available system updates. A confirmation message is displayed at the conclusion of the transmission process to confirm transmission was successful. If instrument updates are sent to the device by the IFMS, the CMS detects the update file and prompts the user to accept and proceed.
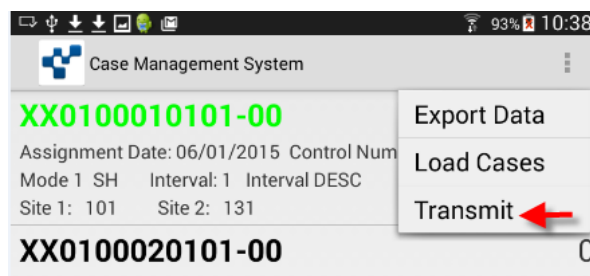
Figure 7. Case Management System Transmit Action Menu

The 'View' option allows the user to sort the case menu by cases that are 'Pending' meaning the cases that have been started but have not been completed in the Assignment Summary Form. This aids the user in verifying the status of their assignments.

The 'Sort' option allows the user to sort their case menu by case ID, event code, assignment date, control number, or county. This feature allows the user to customize the case menu in the manner that is most useful to them and to minimize the time it takes to locate the desired case.

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3. Intercept Form

The intercept form is accessed from the main menu. Each intercept has a predefined unique case ID. The user selects the desired intercept and the form opens with prefilled information from the draw such as intercept number, state code, county code, etc. The user is immediately prompted to start the GPS capture, and an automated satellite request is sent for a GPS location that is stored with the intercept.
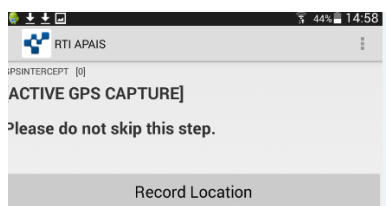

Figure 8 Intercept Form GPS Capture

Predefined list options are presented where possible, allowing the user to tap selections to expedite data entry.
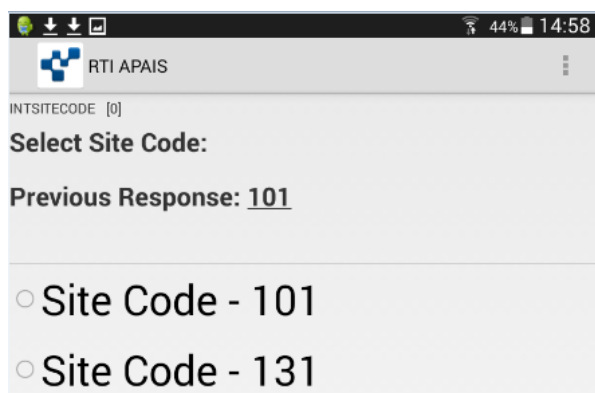
Figure 9. Intercept Form Site Code Option Selection Screen

Incremental seek options are provided to the user when they are prompted for the state, county, or fish species. The user enters the first few characters and the associated entries fill the list and wait for the user selection and confirmation.

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Figure 10. Intercept Form Incremental Seek for State

When the user is weighing and measuring a fish, they are presented with the option to take a photo of the fish. The photo filename matches the case ID, and filenames update sequentially as additional photos are added.

Figure 11. Intercept Form Photo Capture Screen

Intercept skip logic was programmed into the application, meaning questions not relevant to the intercept are not displayed. For example, there are certain questions that are asked if an angler is fishing on a boat, but these questions were not displayed if the angler was fishing from shore. In these instances, the default value is instead ascribed on the back end. This type of

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programming is essential in reducing common data errors found on the paper forms. Additionally, a CARI (Computer Audio-Recorded Interview) feature was implemented in the

final month of the pilot.

Figure 12. Intercept Form CARI Consent

4. Assignment Summary Form

The Assignment Summary Form is also accessed from the main menu. As with the intercept form, data items such as control number, state code, county code, and mode are pre-loaded, negating the need to enter them and expediting the data entry process. Other items are programmed in defined lists, allowing the user to tap the appropriate choice and further reducing potential keyingerrors.

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Figure 13. Tournament Weigh Station

Figure 14. Reason for Leaving Site

Numerous data validations are built into the logic to help users identify possible data entry errors. A simple example is the start and stop times for a site. The stop time must be after the start time. If it is not, an error message appears prompting the user to correct the entry.

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Time 1

End time must be after start time 1201.

Please correct your entry.

Figure 15. Start and Stop Site Time Validation Error Message

When the user is ready to complete an assignment, they sign off by entering their interviewer ID into the last screen of the Assignment Summary Form. Once this is entered, the case is coded as complete and disappears from the Main Menu. The data is transmitted during the field interviewer's next transmission session.

*Please STOP and review your Assignment Summary Form for accuracy and completeness!

*Back up through the form if necessary to check/ change answers.

I Certify that I have reviewed the information in this report and it is accurate

Enter Interviewer ID:

Figure 16. Field Interviewer Sign Off

Field Assignments

NOAA Fisheries supplied the assignment sample draw on a monthly basis for the four months of field testing, August through November 2015. The pilot was conducted in Rhode Island with RTI managed field staff and in South Carolina with SC Department of Natural Resources staff. All staff members also conducted the standard APAIS study during the time period of the electronic tablet pilot. Field staff varied in age and technology aptitude offering a diverse group of opinions on the tablet functionality.

Assignments were drawn within a specific assignment mode per month targeting anglers only fishing from unique access points (SH = Shore, MB = Mixed Boat – Private, Rental and Charter boats). Below are the number of assignments drawn in each state by mode and month:

State	Month	Mode	
		Shore	Mixed-Boat
RI	Aug	7	16
	Sept	7	16
	Oct	8	15
	Nov	8	14

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SC	Aug	7	20
	Sept	7	20
	Oct	7	21
	Nov	7	21
TOTAL		**58**	**173**

Table 1. Tablet Pilot Assignments

5. Results

RTI and NMFS analyzed the results of the tablet data collection for numerous metrics, including production, costs, timeliness, error rate, added benefits, and catch estimation. These five variables are discussed in detail below.

a. Production

To analyze the performance of the tablet in the field compared to the paper form we calculated Percent Intercepts Collected (PIC). We calculated PIC to help quantify whether the tablet was keeping pace with the paper forms in terms of total interviews collected as a proportion of total eligible anglers.

$$PIC = \frac{\text{Total Intercepts Collected}}{(\text{Total Intercepts Collected} + \text{Total Angler Counts})}$$

Total angler counts refers to all eligible anglers that were not interviewed during the six hour interval, including initial refusals, confirmed and unconfirmed trip counts, language barriers and key question refusals. Ineligible anglers (commercial, targeting shellfish, etc.) were not included in the Total Angler Counts variable.

First, we calculated the PIC based on mode and state. Overall, the tablet seems to struggle with collecting boat mode intercepts, but does relatively well with shore based anglers. We anticipated a drop in the mixed boat production, but did not expect such a dramatic decline for both Rhode Island and South Carolina.

State	Mode	Tablet: Asgn count	Paper: Asgn count	Tablet: Intercepts per asgn	Paper: Intercepts per asgn	Tablet: PIC	Paper: PIC
RI	SH	30	122	2.6	2.7	81.9%	84.6%
RI	MB	61	195	1.1	2.8	46.6%	81.3%
SC	SH	28	40	3.8	14.1	41.8%	56.2%
SC	MB	82	109	2.4	7.9	24.0%	53.8%

Table 2. Tablet vs Paper Productivity: Mode Comparison

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There are numerous factors that can help explain this apparent drop in production. First, the assignment intervals were not kept constant with the paper study. The sample draws were produced step wise, meaning that the sample for the main paper study was produced first and then the tablet assignments were drawn from the remaining available sample cells. This method shifted numerous tablet assignments to less productive intervals (B/C) and day types (weekdays). The lack of peak interval weekend assignments helps explain the decline in intercepts per assignment. Second, when field samplers are interviewing groups of anglers off a single boat on the paper form, they often employ shortcuts to help maximize the number of intercepts collected. The most common shortcut observed in the field is recording multiple responses on a single form in available white space, and then transcribing those responses later on their own individual forms. Although this is not how the form was designed to be used, it is a common practice in the field. The tablet does not allow such shortcuts and forces the interviewer to go angler by angler to complete the intercept form. When intercepting large boat parties, the tablet often only produced one or two interviews, but the paper form often allowed interviewers to squeeze 5 or 6 interviews from a large fishing party. This also likely explains why the tablet appears to perform much worse in mixed boat mode assignments as compared to shore mode

To help compare the tablet and the paper forms more fairly, we wanted to compare only assignments that were conducted in the same mode, wave and time interval combinations. Out of 34 potential combinations, only 13 had both a tablet and paper assignments completed.

State	Mode	Wave	Interval	Tablet: Asgn count	Paper: Asgn count	Tablet: Int per asgn	Paper: Int per asgn	Tablet: Percent anglers intrcptd	Paper: Percent anglers intrcptd
RI	SH	4	B	5	5	3	4.8	88.2%	85.7%
RI	SH	5	B	4	3	1.3	1.7	62.5%	71.4%
RI	SH	5	C	11	9	4.5	3.8	80.3%	85.0%
RI	MB	4	B	12	7	2.3	0.7	28.3%	15.2%
RI	MB	4	C	4	7	3	2.7	100.0%	100.0%
RI	MB	5	B	17	10	0.5	1.9	100.0%	61.3%
RI	MB	5	C	14	12	1.5	2.3	72.4%	87.1%
SC	SH	4	C	6	2	4.3	4	39.4%	26.7%
SC	SH	6	B	7	2	0.9	4.5	66.7%	75.0%
SC	MB	4	B	9	6	3.7	13.8	47.1%	53.2%
SC	MB	5	P	11	3	0.9	4.3	40.0%	100.0%
SC	MB	5	B	30	6	3.6	6	18.6%	48.6%
SC	MB	6	P	21	3	0.5	4.7	28.6%	43.8%

Table 3. Unique Assignment Combination Productivity

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Again, many factors contribute to the ability of an interviewer to gain an intercept, but when normalizing for mode, wave and interval, we see that the tablet does very well at keeping pace with the paper forms. The tablet outperformed the paper forms in terms of PIC in Rhode Island and South Carolina on roughly 30% of assignment combinations. The tablet did struggle in mixed boat mode in some assignment combinations, but the paper forms did not do exceptionally well in those same sample cells. The tablet works very well in shore mode assignments because survey protocols dictate that shore mode anglers must be interviewed individually. If the survey were to be redesigned to a boat-based survey, rather than an individual angler survey, we believe the tablet would outperform the paper form in terms of productivity relative to PIC.

b. Cost

The cost of Android tablets has decreased significantly in the past few years and continues to decline. For this project we purchased Samsung Galaxy Tab 4's, a sturdy protective case and mobile charger all from Amazon.com. Table 4 outlines total cost for materials.

Equipment	Unit Price	Total Cost
10 Samsung Galaxy Tab 4	$165.00	$1,650.00
10 Unicorn Bettle PRO Case	$19.99	$199.90
10 Samsung Vehicle Charger	$13.33	$133.30
TOTAL		$1,983.20

Table 4. Upfront tablet costs

Field costs are fixed in both the tablet and paper studies because the interviewers must travel to the site(s) and conduct interviews over the full six-hour interval. Development/programming costs are also negligibly different for each survey method because there is comparable level of effort to produce a functional data entry system whether it is Android-based or PC-based. The true cost savings are recognized in the data entry costs.

Tablet data collection transferred the burden of data entry from the Raleigh, NC-based APAIS team to the interviewers in the field. The APAIS contract mandates a Service Contract Act (SCA) wage for hourly employees, which is set at $12.97 per hour for a Data Entry Operator in Wake County, NC. The average time to key a paper APAIS assignment was 15 minutes with high levels of variability depending on the number of intercepts collected. Knowing these inputs, we could calculate the cost-savings associated with the completed tablet assignments.

Tablet Asgn Count	Time to Key Enter	Total Time	Cost per hour	Total Cost

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	in Hours	to Key Enter		
201	0.25	50.25	12.97	$651.74

Table 5. Cost to manually key tablet assignments

We recognized a cost savings of $651.74 over the four months of the pilot by completing 201 assignments on the tablet rather than manually keying the data. However, the tablet assignment quotas were less than the normal assignment quota for the main study. If the tablet were to be used in only Rhode Island and South Carolina to complete the main study, the upfront costs of the tablet would almost be recouped after just four months.

State	Paper: Asgn count	Time to Key Enter	Total Time to Key Enter	Cost per hour	Total Cost
RI	317	0.25	79.25	12.97	$1,027.87
SC	149	0.25	37.25	13.97	$520.38
				TOTAL	$1,548.26

Table 6. Savings for paper form data entry

Keeping all other costs fixed, use of tablets to administer the APAIS between August and November in Rhode Island and South Carolina would save $1548.26. Rhode Island (756) and South Carolina (378) completed a total of 1,134 shore and mixed boat assignments in 2015; if all 1,134 assignments were completed on the tablet application, $3,677 would be saved in data entry costs easily covering the upfront hardware costs in the first year and earning an additional $1,693.80 in savings.

Reduction in printing costs would also be realized as tablets completely replace the need to print paper forms. During the pilot, 231 total assignments were completed comprising 945 intercepts. This translates to a total of $59.01 in savings of printing costs. While not a notable value for the pilot study, extrapolating to encompass the more than 50,000 intercepts and 7,000 assignments completed each year yields significant cost savings.

It should be noted that tablet costs have declined even further in the time since hardware was purchased for this project. The same tablets are now selling for $129.00 on Amazon.com, further reducing the upfront costs by $360 for the same 10 tablets. As technology continues to advance and becomes more affordable, the tablet solution will generate more and more savings to the APAIS project.

c. Timeliness

Faster availability of fisheries data is an additional priority addressed through electronic data collection. The pilot investigated improvement in data timeliness for data collected with the

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tablet versus paper forms. For the standard paper survey, it takes on average 17 days from assignment completion in the field until it is first keyed into the database. This delay is the result of many factors including staff-delayed shipping, transit delays, and processing procedures (i.e. assignments with intercepts are prioritized to be key entered first and single ASF's are keyed second). Data prioritization is essential to meet the project timeline of having all available biological data available for review on the 10th of the following month in Fishdump. Fishdump allows all project team members to review a monthly data set of all the biological data collected to catch any errors prior to final delivery. As expected, the tablet performed much better in terms of timeliness with a zero day average between assignment completion and data being transmitted into the database. There were initial programming costs associated with getting the data into the correct format from the Mobile FS data scheme to the APAIS database format, but once that process was established and tested, the data came in seamlessly.

The 17 day improvement associated with the tablet data could be a game-changer for fisheries management and data review. Data being available for review on a weekly or even daily schedule could greatly improve in-season monitoring by allowing harvest estimates to be produced more frequently. There would need to be improvements to the entire suite of MRIP surveys, but having the APAIS data available much more quickly is a great starting point.

d. Errors

Error rates were very similar between the tablet assignments and paper assignments. We calculated the rate of INTCHCK (the APAIS error checking SAS program) errors between the two modes and found that they were relatively equal at about .02 errors per assignment. However, this error rate could be close to zero on the tablets with additional programming. After training sessions with the staff in Rhode Island and South Carolina, we immediately received feedback that they did not want any hard stops for invalid entries or range checks to confirm entry. Field staff were concerned that the tablet would already be slower than a paper form and they did not want any additional steps that would force them to stop and correct data in the middle of an interview. As such, we programmed the tablet with minimal range checks and allowed field staff to scroll back through all data prior to transmitting to RTI. Additional programming could allow more hard stops and on the fly validations once the staff were comfortable enough with the tablet and work flow.

e. Added Benefits

i. Photographs

One advantage to the tablet is the ability to capture pictures of fish on the built in 3.0 megapixel camera and transmitting the photo with the assignment data. The photo allows quick confirmation of questionable species or lengths within a day of completing the assignment. Currently, the best method for questioning species, lengths, and weights is during

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monthly data reviews which could be over four weeks after the data was initially collected. This outdated method relies purely on sampler recall to confirm or dispute the submitted data. The ability to capture and quickly transmit images from the field could greatly help improve data quality and error resolution for these unique data elements.

Photo 1. Atlantic Mackerel from Rhode Island

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Photo 2. Red Drum from South Carolina

ii. GPS

Built in GPS technology in the tablet recorded latitude and longitude while in the field to confirm location of samplers while on assignment. This was not an active GPS that allowed RTI staff to monitor the samplers' every movement, but a passive GPS that could be recorded when convenient for the sampler. The GPS capture screen appeared in each intercept as well as the Assignment Summary Form. Location data was particularly helpful when an invalid site error occurred in South Carolina. The sampler had accidentally entered the wrong site code for the assignment, producing an error when validating the data after he transmitted. The sampler luckily was able to capture a GPS ping when he was on site and we were able to use that data to confirm he was at the correct site by comparing the latitude and longitude data from the assignment to the Site Register data online. We were able to salvage an entire assignment worth of data that might have otherwise been excluded due to a sampler recording data incorrectly.

f. Catch Estimates – *For NMFS*

6. Discussion

We feel that electronic data collection would be extremely beneficial to the APAIS project and should continue to be pursued for full implementation. The improvement in data timeliness is an incredible advantage of mobile data collection and a huge benefit for managers and scientists looking for more real time data from the recreational sector. Cost savings are quick to

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be realized even with upfront costs associated with hardware purchases. The ability to control and limit errors was not fully utilized in the pilot due to field concerns, but the potential to continually improve data quality still exists through the use of photos and GPS. This pilot project proves that the ability exists to transform the APAIS survey from a paper data collection instrument to a tablet based survey, and there are numerous benefits to be gained in doing so.

The pilot project was not without its challenges. RTI did overcome obstacles and received helpful feedback from the field during the pilot. Below are a few of the challenges that occurred during the pilot, which should be considered in future development.

1. Version control in the field – Throughout the pilot, RTI was receiving feedback from the field about programming glitches or recommendations for improvements. For example, the type 2 catch grid was developed as a loop function that was not allowing samplers to get out of the grid. When RTI was made aware of the issue, we quickly developed a fix and rolled it out to the field through their next transmission. We made everyone aware of the update, provided instructions on how to install and asked for any feedback if it did not work. When we didn't hear any communication from the field, we assumed that the installation went as planned. That assumption turned out to be incorrect. We had samplers in the field that were frustrated because their install did not work properly and they continued to struggle with problems that should have been fixed with latest update. Once we found out that the updates were not installing correctly, we adjusted our installation instructions to include how to verify the correct version of the program was installed. That helped alleviate the issue of proper version control and we were able to quickly identify any samplers and tablets that needed direct support. Communication is essential to and from the field, and building a communication plan into the project schedule will help ensure success in future deployments.

2. Overcoming perceptions – Change is always difficult and an instrument change is especially difficult to implement in the survey world. The tablet was initially received very poorly by a few field members because it felt slow and eliminated many of the shortcuts they were able to utilize on the paper form. When doing field visits with the tablet, a sampler said, "[The tablet] makes me look stupid." The sampler was referring to the perception that the tablet was taking too long to complete an interview. Immediately after this, an intercept was completed in under a 60 seconds; however, there were no type 3 fish to weigh and measure. There was a perception in the field that the tablet was just not as efficient as the paper form, but we believe with a few procedural and instrument adjustments the negative attitude could be improved.

3. Fish slime – The largest drawback witnessed in the field was the ability to process a large cooler of fish in the type 3 catch grid quickly. Handling numerous fish one after another causes slime build up on the samplers hands and tablet. Even with constant toweling off and wiping, the tablet was very sensitive to the buildup of slime on the touch screen

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often causing taps and swipes to be unrecognizable. An assignment was observed when two angles returned to a ramp with a total of 100 fish in a cooler (50 fish per day limit). The sampler was able to get through about 10 total fish before the tablet started not recognizing taps and swipes causing sampler frustration. Normal survey procedures dictate that no more than 15 of each species per angler (30 total in this example) should be weighed and measured and all grouped catch should go on the first angler of the party. The sampler was unable to get to the 30 spot for this fishing party due to the quick buildup of slime on the tablet. Again, with further procedural and tablet adjustments, there may be a more efficient way to collect the type 3 data with minimal frustrations.

Photo 3. Large numbers of fish are difficult to process.

4. Computer Audio Recorded Interview (CARI) Technology – During the pilot, RTI distributed an update to the tablet that allowed samplers to record interviews with respondents. The respondents were made aware of the recording at the beginning of the interview and had the ability to decline the recording while still granting an interview. This technology was met with extreme disdain from a few members of the field sampling team and production was not as high as we would have hoped. We are unable to directly link the lack of recorded interviews to a procedural issue or a general refusal from the recreational anglers. There could be public perception from the fishing

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community that the survey is not only invading on their recreational activity, but is doing so even more by now recording these conversations. Although explanatory language was added into the interviewing script that the recording was used for quality control purposes only, we believe there was general mistrust from the public regarding recorded interviews. This may be the level at which recreational anglers protect their information or it could just be reflective of the current level of trust citizens have with any perceived authority.

For the interviews that did transmit, most were extremely clear and we were able to clearly here the question being asked by the sampler and the response from the angler. This could be an extremely valuable quality control measure moving forward by allowing supervisors to remotely listen to how questions are being asked in the field and verifying that information with the transmitted data. Not all interviews were able to be heard clearly as wind seemed to muffle the microphone and completely mask the conversation between the sampler and angler on more than one occasion. Of the 17 audio recordings that were transmitted from the tablets, 14 came in with clear, understandable audio content. We believe that this tool can be successfully rolled out in the APAIS survey and would cut down on travel time and costs associated with field observations.

7. Next steps

RTI believes the next appropriate step is to roll out the electronic data technology for full field implementation of the APAIS survey. With further adjustments to the instrument, the tablet can become even more streamlined and user friendly. One sampler said, "I wish the tablet would learn," meaning that customized lists of angler responses that allow faster data entry in the field would be well received. The benefits and cost savings greatly outweigh the upfront technology costs associated with the tablets. There was a limited budget to program the instrument and cover all field costs, but we believe with additional funding to improve the tablet program and address any survey procedural adjustments, this program could pave the way for electronic data capture from the recreational industry.

We would like to thank the Rhode Island and South Carolina field samplers for their efforts during the survey and all the feedback they provided.

Appendix A – Training Guide

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Guide to Using Mobile FS on Samsung Galaxy Tab 4 Tablets for APAIS Interviews

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Charging the battery

Each device should come with a white AC cord. Devices should be charged every night to ensure a full charge for the next day. Once charged the devices should have plenty of charge for a full day of interviews.

The AC will plug into the device at the very bottom as show in the photo. (Tip: Look for the USB logo on the end that plugs into the device; it will always point up. This will help you figure out which way to plug in the cord.)
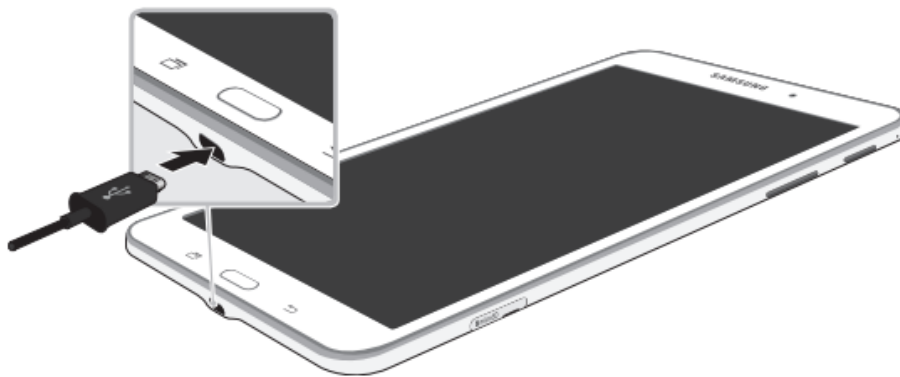
The AC cable is a USB cable. You can't remove the USB cable from the AC charging head (the part with the plug) and use your computer to charge the device. The USB cable must be plugged into the charge head as shown below.

Note: If the battery is completely drained allow it to charge for a few moments before turning on the device.

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Turning the device on and off

Turning on the device
If the device is not turned on, press and hold the **Power/Lock Button** as shown in the illustration.

You can tell if the device is turned off or not by quickly tapping on the **Power/Lock Button.** If the screen turns on after a quick press the device is already on.

Turning off the device
Press and <u>hold</u> the **Power/Lock Button** and then select "Power Off" then "OK".

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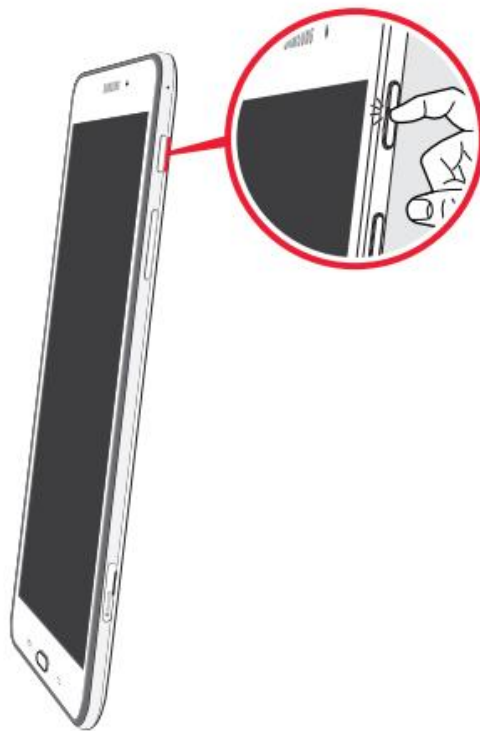
Locking and Unlocking the device

Putting the display to sleep ("locking")

The display on the device will automatically turn off after about 10 minutes of not using it (this is called the device "locking"). The device itself will still remain powered; only the screen will turn off in order to preserve battery power.

You can also lock the device manually to save batter power by <u>quickly</u> tapping the **Power/Lock Button** (see Error! Reference source not found. on page **Error! Bookmark not defined.**). If you hold the button you will get a "Device options" menu; to get rid of this just click anywhere outside the menu and quickly hit the **Power/Lock Button** to lock the device**.**

Unlocking the Device

If the screen is off but the device is powered, you will need to "unlock" the device.

1. Press the **Power/Lock Key**. The lock screen displays
2. Swipe right across the screen as shown.

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The buttons on the device

1. **Front Facing Camera** (not used)
2. **Microphone** used for recording audio. Be sure not to cover this!
3. **Power/Lock button**. Used to lock, unlock, power on and power off device.
4. **Volume buttons** (not used)
5. **Infrared blaster** (not used)
6. **Memory card slot** (not used)
7. **Back Key**: Return to a previous screen or option
8. **Home Key**: Used to display the "Home Screen". On the home screen you will find the link for the survey app.
9. **Recent Key** (not used)

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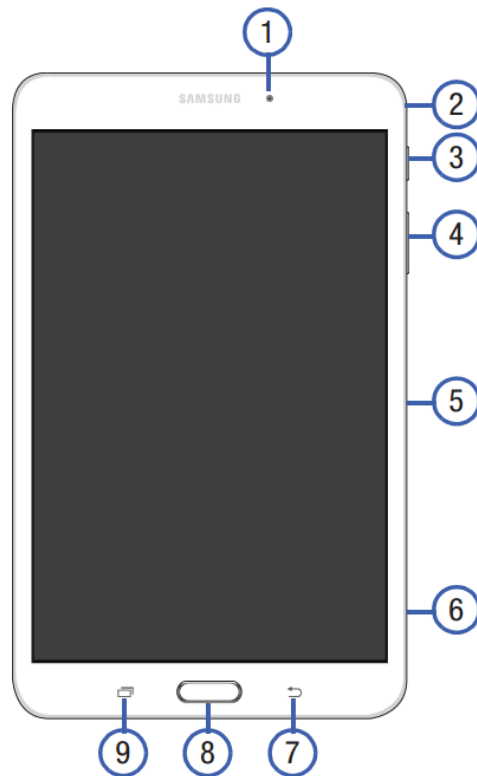
The Back Button

If you are in a screen, and you need to go back, press the **Back Key** (see "The buttons on the device" on page 28 above.)

Note that the back button does not work during the survey. If you would like to go back to a previous question, swipe back with your finger from left to right, as if you were flipping a page in a book to a previous page.

How to Connect to Wi-Fi

Note that these instructions are only required when connecting to a new Wi-Fi signal for the first time. After connecting, the device will "remember" the Wi-Fi signal and will automatically connect to it. Only use these instructions if you need to connect to a new Wi-Fi signal or if you are having problems automatically connecting.

1. Be sure your device is unlocked (see Unlocking the Device on page 27).
2. Make sure you are at the home screen by hitting the Home button (see The buttons on the device on page 28).
3. Click on the application button at the bottom of the home screen (see circled area).
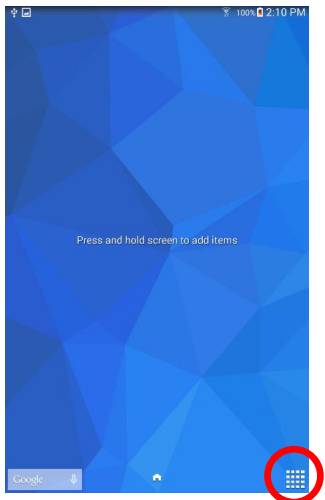

4. In the applications screen click on "Setting". It may be in a slightly different place on your screen (see circled area).

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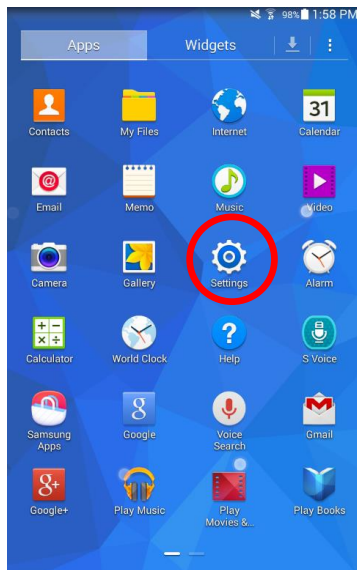

5. After entering settings be sure "Wi-Fi" is selected (it will be surrounded by blue shading as shown below). Additionally the "switch" below it should be green (see red arrow in photo pointing to switch). If it is grey then Wi-Fi is turned off. Turn Wi-Fi on by tapping on the switch.
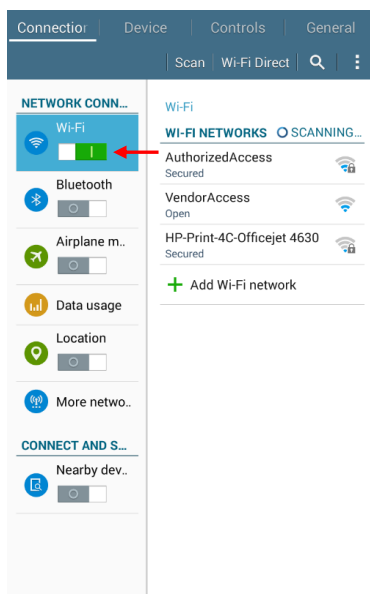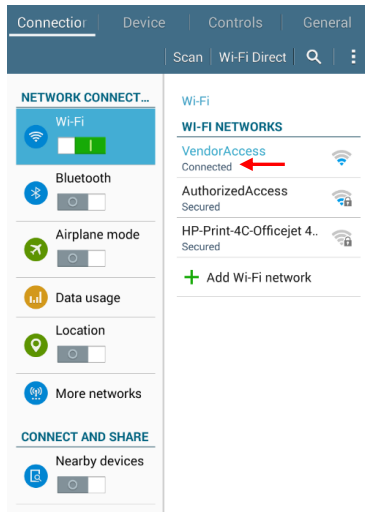

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6. Select the Wi-Fi network you want to connect to. In the example below, the device was connected to "VendorAccess", but your network may be different. After selecting the network, and entering the passcode if needed, press **Connect**.
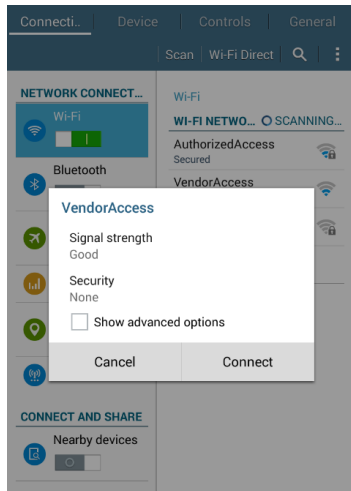
7. You should see confirmation that you have been connected by seeing "Connected" under the network name. See the red arrow pointing to this notification below.

After connecting you should see a Wi-Fi icon at the top right of the screen as shown below to give details on your connection.

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Displays when Wi-Fi is connected, active, and communicating with a Wireless Access Point (WAP).

Displays when there is a Wi-Fi network is available but you are not connected to it. It may also display if there is a communication issue with the Wireless Access Point (WAP).

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How to Use the Survey Tool (Mobile FS)

General Information

We are using a survey tool called "Mobile FS", an Android program that RTI created, to record participant responses to the survey. In general, here is how the process will work:

1. You will open the Mobile FS program on the Android tablet and start a new assignment.
2. You will read the questions from the screen out loud and then tap on the screen to record the participant's answers. You will swipe right to left to advance questions (like flipping pages in a book).
3. The survey responses will be saved on the tablet.
4. Every night of an assignment, you will connect the tablet to the internet to transmit the survey data to RTI.

Starting and Logging Into Mobile FS

Click on the "RTI Mobile FS" program as shown below.
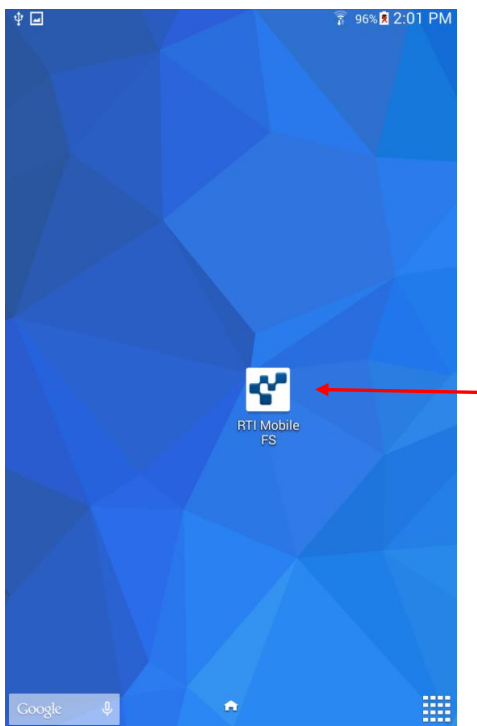
1. You will then see a screen with the title "Case Management System."

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2.   Check that the date and time are correct. If they are correct, select the box called "The system clock settings are correct." Having the proper time is important!

3.   If the date and time settings are *not* correct, tap **Set Clock**, and you will be directed to the screen where you can change the settings on your device.

4.   Next, enter the password gats (all lowercase) and select "Login".

As a security feature, you will see asterisks on the screen when you type your password. Exercise care when entering the password. You have five chances to type the correct password. If you enter the incorrect password five times, the device will lock you out, and you will have to enter an unlock code to regain access. If you are locked out, RTI will assist you in obtaining the unlock code.

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The Case Management System

Once you have logged into Mobile FS the first screen you will see is called "Case Management System". You will see here a list of assignments that are identified with a numeric ID code. Listed under those codes is:

- Assignment Date
- Control Number
- Mode (1 = Shore, 7 = Mixed Boat)
- Interval (3 = 0800-1400; 5 = 1100-1700, 4= 1400-2000)
- Site 1 and Site 2

Each case is for one person and will be assigned to that specific tablet. You should complete all assignments on your tablet as they are scheduled.

Start a New Survey

To start a new survey, click on a white case. You should select the assignment corresponding to the day you are working. After clicking on a case you will see an option to start an Assignment Summary Form or an Intercept from screen below. An ASF and intercepts will need to be filled out for each Control number and you will have to toggle between the two during your 6-hour interval. Click on "**Start Interview**" to start the interview. You can also click on "**Back to CMS**" to return back to the Case Management System. (We are not using the **Record of Calls** function.)

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Once you select the Assignment Summary or the Intercepts form you will see the following case details page. Click on "**Start Interview**" to start the interview. You can also click on "**Back to CMS**" to return back to the Case Management System. (We are not using the **Record of Calls** function.)
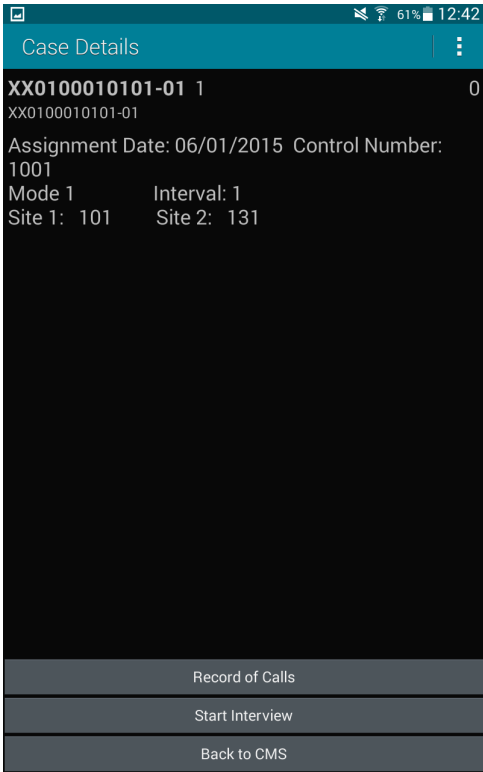
The interview will then start.

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Advancing Questions in the Survey
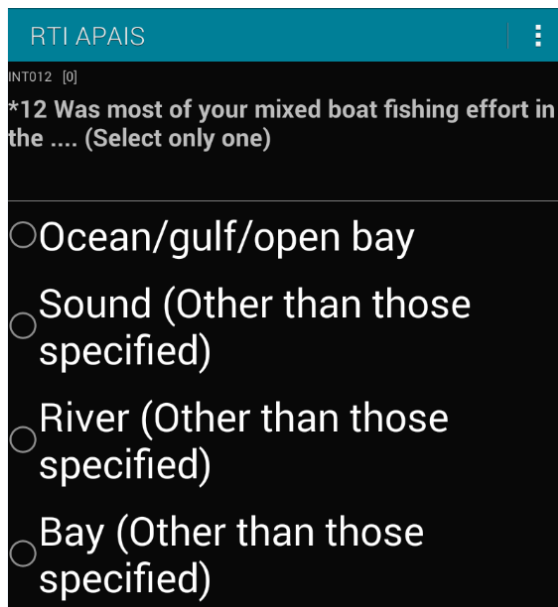
To advance to the next question in the survey you will swipe on the screen from right to left, as if you were flipping a page in a book. You can do this even if the keyboard is open, just swipe above the keyboard so that you don't type letters while swiping.

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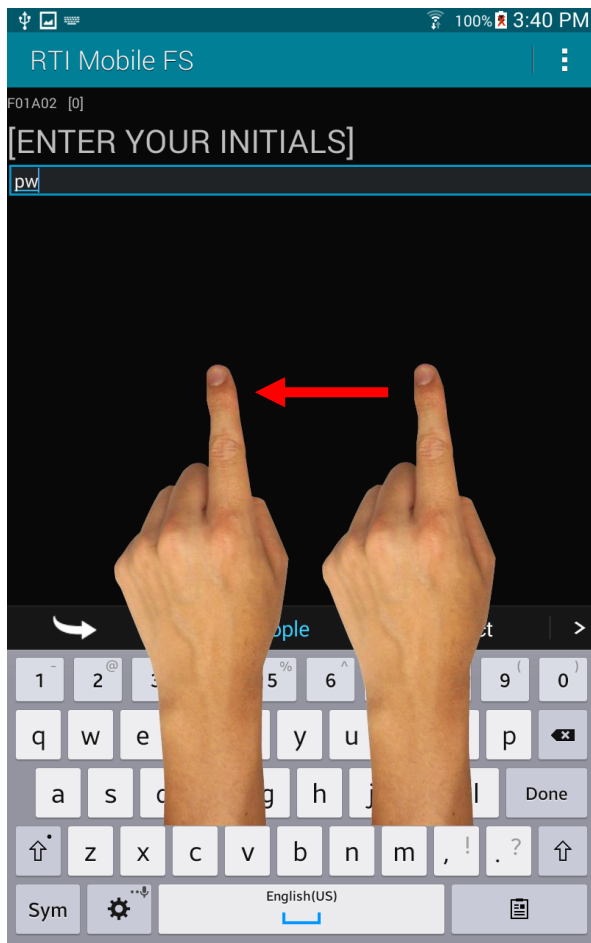
Question Types

Select One

Many questions in the survey are "select one" responses. That is, the person can only provide one answer (like "Yes" or "No") and then you select the answer they gave you. Select one responses can be identified by the round radio buttons:
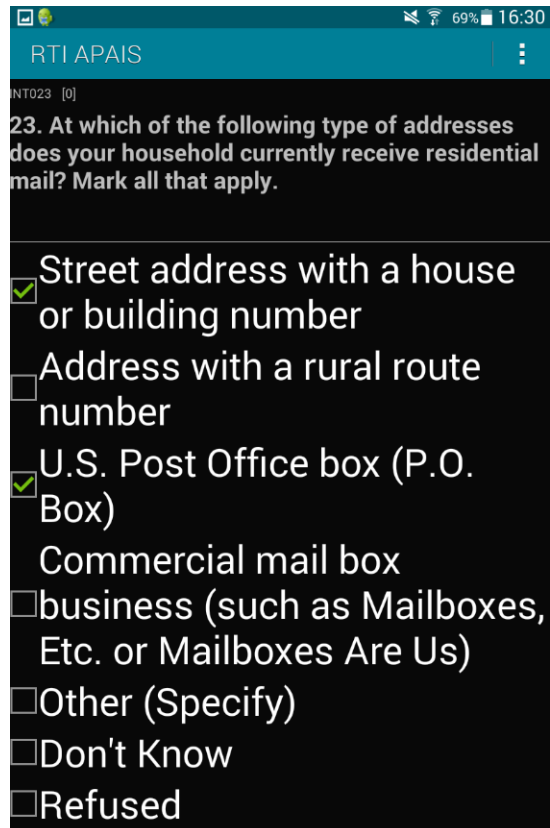
Select Many

Some questions allow you to select more than one option. For example, a question asks how the person receives residential mail.

Select many questions are easy to identify because they use square check boxes instead of round radio buttons. Additionally, the interviewer instructions will say "Mark all that apply".

Open Ended Responses

A few questions are open-ended, that is they allow for a free response. You record responses by typing on the keyboard.

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Number Entry

For questions that require you to enter a number a number pad will appear. Simply type in the digits and then swipe from right to left to advance to the next question. Note that for phone numbers you do not need to enter parentheses or dashes; only enter numbers.

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Incremental Selections

The species and state/county of residence question has an incremental selection function. Similar to the open ended question, you begin typing on the keyboard and the available options will be whittled down for you. You then select that option, BUT you must confirm with a second tap that the correct species was selected. See below
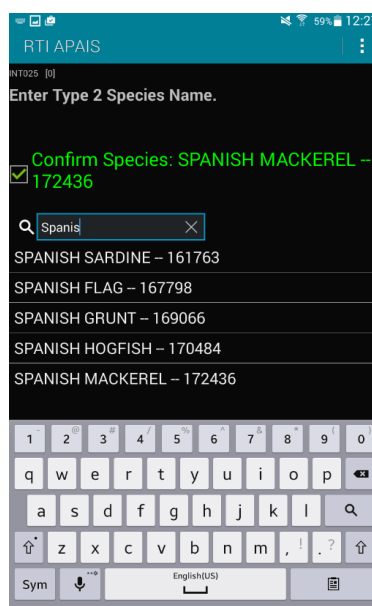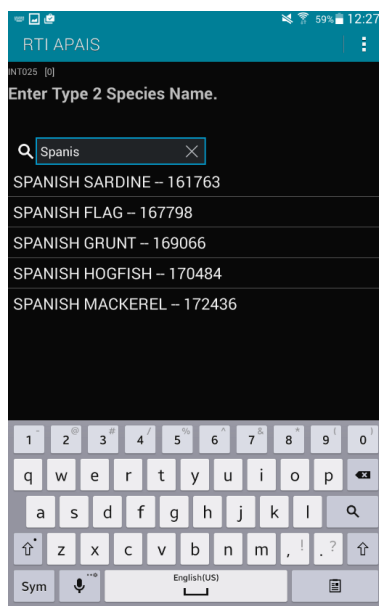
"RTI Report - Contractor's Summary Report of Pilot Trial", page 43

Finishing a Survey

After swiping to the last question you will see a button that says "Exit". Press **Exit** and the interview will finish and save. You will be taken back to the Case Management System.
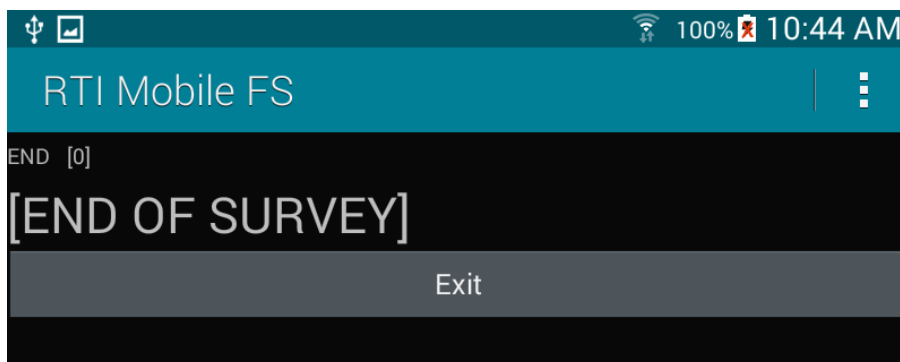
Transmitting Data to RTI

If this were a paper and pencil survey, every night you would have to mail a box of surveys to RTI for processing. Thankfully, with Mobile FS, you can send data to RTI every night with a press of the button.

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1. Be sure you are connected to Wi-Fi.
2. To access the transmission button first click on the **Menu** button at the top right of the CMS main screen.
3. Then click on **Action**.
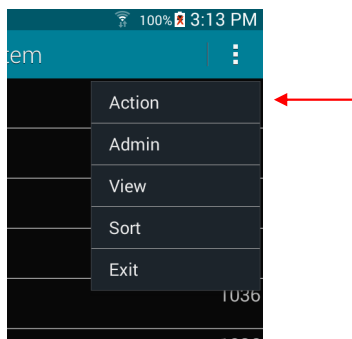
4. Click on **Transmit**
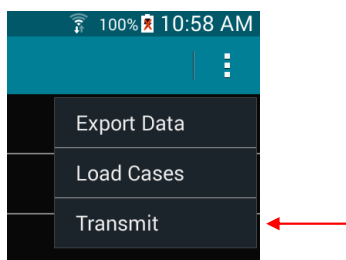
5. At the bottom of the screen click on **Start Transmit**.

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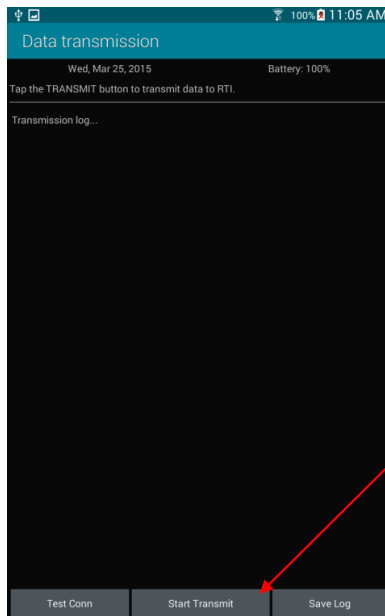
6. You will see a message "Transmitting Data".
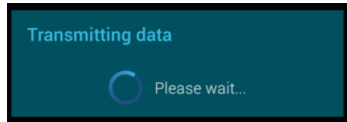
7. Once finished you will see a message in the log that says "Transmission Successful". Click on the **Back** button on the tablet (see "The Back Button" on page 29) to return to the Case Management System. Note: After transmitting you may get a message that an update to the survey is available. See "Survey Updates" on page 46 below.

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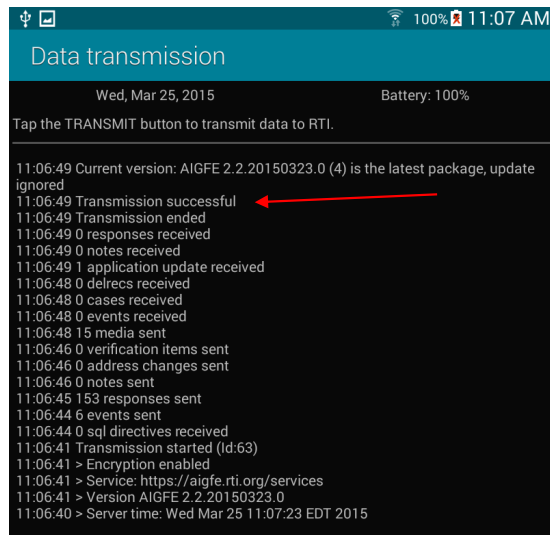
Survey Updates

When you transmit data to RTI, Mobile FS will also check for updates to the survey. Updates may be used to correct minor issues with the survey. To update the survey:

1. Click **OK** in the "App Update" dialog box.
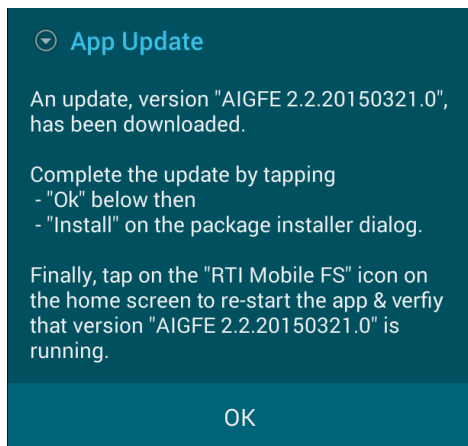
2. Click **Install** in the next dialog box.

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RTI Mobile FS

Do you want to install an update to this existing application? Your existing data will not be lost. The updated application will get access to:

New | ALL
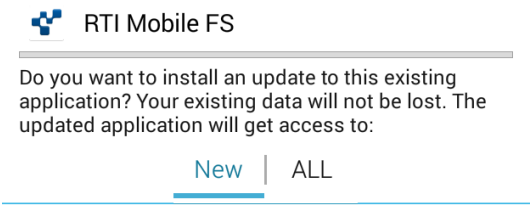
This update requires no new permissions.

| Cancel | Install |

3. Click **Decline** when asked about Google checking the device.

RTI Mobile FS

Installing...

Allow Google to regularly check device activity for security problems, and prevent or warn about potential harm.

Learn more in Google Settings > Verify apps.

| Decline | Accept |
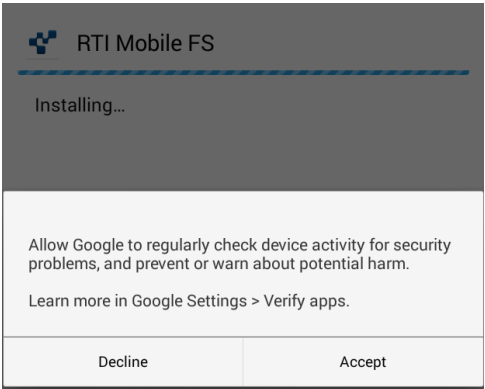
4. The program will automatically close so that it can update. To restart the program click the RTI Mobile FS icon on the home screen.

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"RTI Report - Contractor's Summary Report of Pilot Trial", page 48
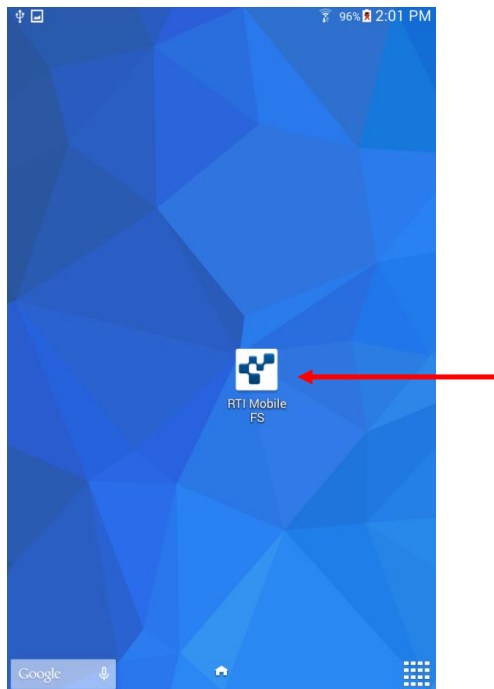
5. You will be taken back to the log in screen to log in. (See "Starting and Logging Into Mobile FS" on page 33)

Early Termination (Break Off) of Survey

An angler may initially agree to be in the survey, but then say they cannot be in the survey after starting it. For example, they need to leave the site after a few questions in.

It is easy to do an early termination, or "break off" of a survey.

1. First click on the **Menu** button at the top right.
2. Click on **Tools**
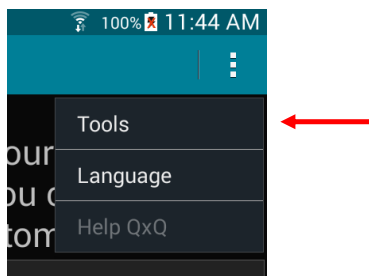
3. Click Break Off

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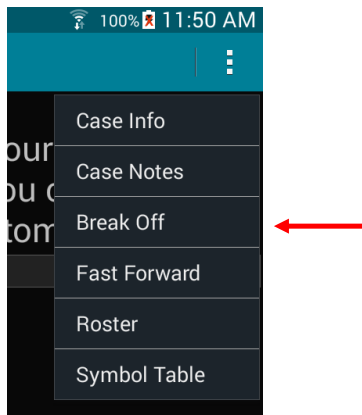
4. Confirm that you want to break off the interview by pressing **Yes**. Note that once you break off an interview you will be able to go back in and overwrite or edit the data **IF the Assignment Summary Form has not been completed.**
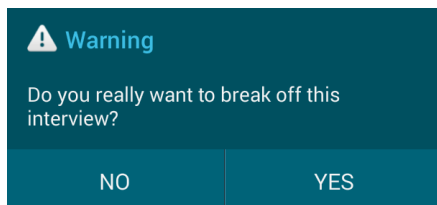
5. Double confirm you want to break off the interview by hitting **Exit**.
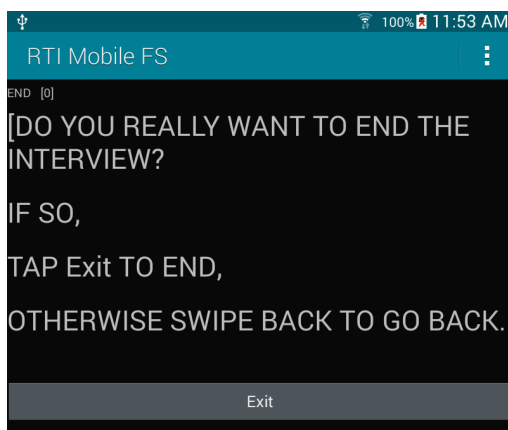
6. You will go back to the Case Management System.

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This intercept is still able to be used again, just as if you received a status 5 interview in the field and did not give the intercept a number. Please remember to include the break off as a status 5 (Refused Key Question) intercept on the Assignment Summary Form.

Case Notes
Within the tablet you are able to record notes to yourself regarding the intercept you are working on.

1. First click on the **Menu** button at the top right.
2. Click on **Tools**
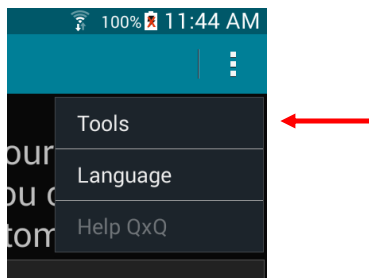
3. Click Case Notes
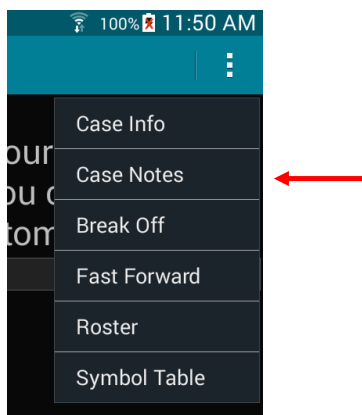
4. Type in any notes needed on the intercept

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Case notes can be accessed from the Case Details screen or the individual intercepts.

Training Cases

Training cases used during training remain on your tablet for additional practice or discussions of certain situations with your FS. All training cases will have an **XX** at the beginning of each case ID. If needed, you can clear out the data entered into the training cases and reload a fresh group of cases to practice with. To reload training cases:

- From the main CMS screen, tap **Menu Button**

- then **Admin**

- then **Reload Training Cases**.

Even if you still have the training cases on your tablet, you can re-load them if you simply want a fresh set of practice cases.

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"Final Project Report with tables figures Tablet Use for APAIS Pilot", page 1

Electronic Data Collection for the Atlantic Access Point Angler Intercept Survey
RTI International and National Marine Fisheries Service

Executive Summary

The overall objectives of this pilot study were to develop and field test a software and hardware system for data collection on electronic tablets during angler interviewing in the Access Point Angler Intercept Survey (APAIS) and that goal was largely achieved. The results were somewhat mixed but generally positive in regards to feasibility of the system's use in the field, cost benefits of implementing the system coast-wide, and in quality of data obtained vs. data quality resulting from paper form data collection, manual key-entry of data, and post-entry data quality controls currently in place in the APAIS.

However, there were several issues raised by both field staff using the test platforms and by the NMFS Principal Investigator about the utility and operational aspects of the developed application. The functionality of interviewing several anglers within a boat party 'simultaneously' by switching among interviews, question by question, was a key attribute requested by field interviewers, but was not programmed into the app due to lack of flexibility in the software platform used. The logistic issues associated with handling fish (wet, slimy) and recording measurements continues to be a minor issue in handling and speed of interviewing. These impediments to rapid interview progress can deter anglers from interviewing and frequently led to some members of an angling party walking off, or refusing participation in the survey. These issues were not typical deterrents to interviewing using paper and pencil. However, overall, the tablet data entry system is a vast improvement for data collection in the field and with software modifications and modernizations should prove to be cost efficient and a great time-saver in data acquisition, processing, and quality.

The objectives of flexible software that can be customized as needed among the Atlantic States (and ultimately all states using APAIS data collection), tablets being a useful hardware platform for APAIS data entry, and both time-saving and cost efficient data processing have all been met in this pilot study. The minor improvements recommended are not out of expectations in modern computer-based systems that are frequently upgraded to take advantage of improvements in both software and hardware development. We recommend implementation of tablet data collection for conduct of the MRIP Access Point Angler Intercept Survey.

Background and Objectives

The National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS, NOAA Fisheries) recently approved a policy regarding the adoption of electronic technology solutions in fishery-dependent data collection programs. This policy states:

"*It is the policy of the National Oceanic & Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NOAA Fisheries) to encourage the consideration of electronic technologies to complement and/or improve existing fishery-dependent data collection programs*

to achieve the most cost-effective and sustainable approach that ensures alignment of management goals, funding sources and regulations."

The policy requires each region, Alaska, Greater Atlantic, Pacific Islands, Southeast and Caribbean, and West Coast, to evaluate the application of electronic technologies to fisheries management within their areas of responsibility. Implementation of this objective requires contract support to oversee and facilitate this agency-wide effort in conjunction with the Regional Fishery Management Councils, Interstate Fishery Commissions, and other stakeholders.

Under contract with NOAA Fisheries, RTI International (RTI) conducted the paper and pencil interview (PAPI)-based Atlantic Access Point Angler Intercept Survey (APAIS) in the thirteen Atlantic coastal states north of Florida from 2012 through 2015. In 2014, RTI's contract expanded to include work in Puerto Rico; this work is ongoing. NOAA Fisheries also contracted with RTI to test the feasibility of electronic tablet-based data collection on the APAIS in the summer and fall of 2015. This work was designed to examine the benefits and challenges associated with operating in marine coastal environments. RTI managed the development, field testing, and implementation of data collection using Samsung Galaxy 4 tablets and RTI's Mobile Field Surveys (Mobile FS) software. The implementation was conducted in Rhode Island and South Carolina using APAIS staff who were familiar with the PAPI survey operation. The field test was conducted August 1st through November 30th, 2015, subsequent to development and field testing.

Objectives

1. Develop software that is adaptable for use in 15 states with flexible questionnaires suitable for use on a tablet.
2. Demonstrate that APAIS intercept survey data can be successfully collected using a tablet under typical field conditions.
3. Increase efficiency in the overall process of collecting and entering data, and evaluate cost savings by eliminating data forms, and hand-data entry staff or OCR hardware/software, while providing seamless integration of data into existing data processing algorithms and schedules.
4. Improve data accuracy via internal data limits and checks at point of entry and QC oversight of field interviewers' activity by automatically recording GPS locations, dates, and times of survey conduct.
5. Provide near real-time data access for survey data users.

A secondary goal of the project was to evaluate the impact of tablet use on productivity of the APAIS by comparing catch estimates generated from each method. This evaluation would take into account the catch composition of the samples, the productivity of interviews obtained per sampling assignment, and the variance of the catch estimates produced from the tablet samples vs the PAPI samples during the same wave. This goal required additional staff support from NMFS/ST1 outside the project team.

Methodology

RTI developed the electronic field survey using RTI Mobile FS, a powerful platform that allows users to conduct field studies on Android mobile devices. RTI Mobile FS is a suite of tools used to

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develop questionnaires for the iPAQ (Windows Mobile), Android and PC/Windows platforms. The suite includes tools for developing questionnaires, changing file formats, updating system options, and creating import files. The system also includes components for data management which allow a user to aggregate data, run reports, export data, and create SAS, SPSS, or Stata input statements for data collected with the system. The standard APAIS paper forms were replicated into the Mobile FS application using the same structure and language as it appears on the form.

RTI selected Mobile FS for the project as it was the most cost-effective and field-ready tool with respect to a budget that encompassed development, testing, data collection, and data management. The request from NMFS was a custom built application that would allow use of the APAIS interview in a similar appearance to the paper form (question followed by check boxes for response choices, or fields for character entry if open response or codes required) and the flexibility to switch among interviews without loss of partially completed interview data. Many 'off the rack' applications could develop the first requirement but the easy switch among partially completed forms was difficult to design and operate efficiently. That lesson was learned by the earlier trials of software/hardware by Macro International, a previous Atlantic Coast APAIS contractor.

Hardware

The Mobile FS APAIS Data Collection System was deployed on a Samsung Galaxy Tab 4 (Model SM-T230) tablet using Android Version 4.4.2. This device was selected due to its cost, size, weight and performance. The Tab 4 weighs only 1.4 pounds and has a 7-inch screen size, ideal for ease of handling for the duration of a six hour assignment. Ten (10) total tablets were purchased: four were deployed in each state, and two were retained by RTI for testing and troubleshooting. Protective covers were purchased to protect the device from environmental hazards and proved to be an ideal accessory for this purpose. The cover was a SUPCASE Unicorn Beetle PRO case (Model: SUP-GalaxyTab4-7-UBPRO-WHGY). These cases provided a high grade polycarbonate case for shock absorption, and a front cover with screen protector to prevent scratches while maintaining touch screen sensitivity. The cases were not water proof, but the dual layer design provided water resistance. No tablets were destroyed during the study due to water intrusion or damage from drops. Interviewers were also provided with a Samsung 2Amp Micro-USB Vehicle Charger (Model: ECA-U21CBEBXAR) to enable mobile charging from their vehicle.

Software

Mobile FS is a native Android application and supports deployment to Android OS versions 4.0 and above. SQLite is used for data storage, and all survey related data is encrypted at rest and synchronized back to the private RTI network via a secure (HTTPS) communication channel.

RTI has developed and delivered the following components to the NMFS:

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- All hardware purchased for the pilot project
- the ANDROID APAIS Mobile application installation file - APAIS.APK
- gats_survey0.db3 – database that houses the Assignment Summary Form Survey
- gats_survey1.db3 – database that houses the Intercept Form Survey
- gats_CMSDB.dbe – database that houses the application configuration and assignment data

The APAIS.APK is a binary executable that can be installed onto an ANDROID device by copying it to the device and executing. The db3 files can be accessed and manipulated with open source tools such as SQL Lite. New question and answer sets can be added to a survey by adding the information into the appropriate db3 file.

Software Architecture

Four major components were developed for the APAIS mobile application: the Case Management System (CMS), a two tiered main menu, Assignment Summary Form, and Intercept Form. Upon initiating the application on the tablet the main CMS screen appears along with informational items: system version, current date and time, and a password entry prompt for logging in. Note: the demo tablet/software includes a "Set Clock" button on this initial screen but if this is operational by field staff it could allow for editing of time by unscrupulous interviewers who arrive late but wish to code the data with the scheduled arrival time – this function should be removed and allow the device to capture the date/time from the service provider, GPS, or fixed by admin only.

The CMS provides the framework for the APAIS Mobile application to operate and is password protected via a Login button. In this application a single 'case' is an APAIS sampling assignment, identified by date, interval, mode, site(s) with state-specific control numbers (provided by the contractor; not the control7 produced by the NMFS assignment draw). Each case would then include a single Assignment Summary Form (ASF) and multiple interview forms (or none if no interviews were obtained.

Upon logging into the application, the case menu displays open assignments to the user. At this point the user has the ability to open the intercept form or the Assignment Summary Form for any of the available assignments to begin collecting data. The user can move between these two options within each assignment by returning to the Main Menu.

Case ID numbers are color-coded, allowing the user quick identification of opened cases. Several variables are preloaded from the assignment draw, including assignment date, mode, time interval (6 hour assignment interval), site numbers (single or two-site clusters), and control number. These variables are essential to help interviewers stay organized and working at correct times and locations. Submenus are also available from the main menu allowing the user to select various options; Action, Admin, and View.

The 'Action' option presents the user with a menu that provides the option to 'Transmit'. This action starts the secure wireless connection to the IFMS (Integrated Field Management System) at RTI and uploads all data collected while on assignment. The transmission process also downloads new assignments for the user and any available system updates. A confirmation message is displayed at the conclusion of the transmission process to confirm transmission was successful. If instrument updates are sent to the device by the IFMS, the CMS detects the update file and prompts the user to accept and proceed.

The 'View' option allows the user to sort the case menu by cases that are 'Pending' meaning the cases that have been started but have not been completed in the Assignment Summary Form. This aids the user in verifying the status of their assignments.

The 'Sort' option allows the user to sort their case menu by case ID, event code, assignment date, control number, or county. This feature allows the user to customize the case menu in the manner that is most useful to them and to minimize the time it takes to locate the desired case.

1. **Intercept Form**

The intercept form is accessed from the main menu. Each intercept has a predefined unique case ID. The user selects the desired intercept and the form opens with prefilled information from the draw such as intercept number, state code, county code, etc. The user is immediately prompted to start the GPS capture, and an automated satellite request is sent for a GPS location that is stored with the intercept.

Predefined list options are presented where possible, allowing the user to tap selections to expedite data entry.

Incremental seek options are provided to the user when the response requires an open entry (typed characters) such as the state and county of residence, or fish species targeted, caught (reported) or landed and examined. The user enters the first few characters, the associated entries fill a list, and the user selects and confirms the response choice.

When the user is weighing and measuring a fish, they are presented with the option to take a photo of the fish. The photo filename matches the case ID, and filenames update sequentially as additional photos are added.

Intercept skip logic was programmed into the application, meaning questions not to be asked due to the response of a previous question are not displayed. However, if the response to the earlier question requires a subsequent question be asked, all the questions are displayed and a response is required to complete the interview. An example is the area fished questions: if area fished response is Ocean, then distance from Shore must be asked; if area fished is any of the Inland bodies (e.g. river, bay, specific estuary) the distance from shore choice is not displayed.

Additionally, a CARI (Computer Audio-Recorded Interview) feature was implemented in the final month of the pilot. This feature was discussed as a possible use of the hardware features, but was not specifically requested by the NMFS.

2. Assignment Summary Form

The Assignment Summary Form is also accessed from the main menu. As with the intercept form, data items such as control number, state code, county code, and mode are pre-loaded, negating the need to enter them and expediting the data entry process. Other items are programmed in defined lists, allowing the user to tap the appropriate choice and further reducing potential data key-entry errors.

3. Case Completion and Data Transmission

Numerous data validations are built into the logic to help users identify possible data entry errors and/or prevent incompatible responses to correlated questions, or invalid responses to any question. A simple example is the start and stop times for a site. The stop time must be after the start time. If it is not, an error message appears prompting the user to correct the entry.

When the user is ready to complete an assignment, they sign off by entering their interviewer ID into the last screen of the Assignment Summary Form. Once this is entered, the case is coded as complete and disappears from the Main Menu. The data is transmitted during the field interviewer's next transmission session.

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Field Assignments for Application Testing

NOAA Fisheries supplied the assignment sample draw on a monthly basis for the four months of field testing, August through November 2015. The pilot was conducted in Rhode Island with RTI managed field staff and in South Carolina with SC Department of Natural Resources staff. All staff members also conducted the standard APAIS study during the time period of the electronic tablet pilot. Field staff varied in age and technology aptitude offering a diverse group of opinions on the tablet functionality.

Assignments were drawn within a specific assignment mode per month targeting anglers only fishing from unique access points (SH = Shore, MB = Mixed Boat – Private, Rental and Charter boats). Below are the number of assignments drawn in each state by mode and month:

State	Month	Mode	
		Shore	Mixed-Boat
RI	Aug	7	16
	Sept	7	16
	Oct	8	15
	Nov	8	14
SC	Aug	7	20
	Sept	7	20
	Oct	7	21
	Nov	7	21
TOTAL		58	173

Table 1. Tablet Pilot Assignments

4. Results

RTI and NMFS analyzed the results of the tablet data collection for numerous metrics, including production, costs, timeliness, error rate, added benefits, and catch estimation. These five variables are discussed in detail below.

a. Production

To analyze the performance of the tablet in the field compared to the paper form we calculated Percent Intercepts Collected (PIC). We calculated PIC to help quantify whether the tablet was keeping pace with the paper forms in terms of total interviews collected as a proportion of total eligible anglers.

$$PIC = \frac{\text{Total Intercepts Collected}}{\text{(Total Intercepts Collected + Total Angler Counts)}}$$

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Total angler counts refers to all eligible anglers that were not interviewed during the six hour interval, including initial refusals, confirmed and unconfirmed trip counts, language barriers and key question refusals. Ineligible anglers (commercial, targeting shellfish, etc.) were not included in the Total Angler Counts variable.

The PIC was calculated based on mode and state. Overall, the tablet seems to struggle with collecting boat mode intercepts, but does relatively well with shore based anglers. We anticipated a drop in the mixed boat production, but did not expect such a dramatic decline for both Rhode Island and South Carolina.

State	Mode	Tablet: Asgn count	Paper: Asgn count	Tablet: Intercepts per asgn	Paper: Intercepts per asgn	Tablet: PIC	Paper: PIC
RI	SH	30	122	2.6	2.7	81.9%	84.6%
RI	MB	61	195	1.1	2.8	46.6%	81.3%
SC	SH	28	40	3.8	14.1	41.8%	56.2%
SC	MB	82	109	2.4	7.9	24.0%	53.8%

Table 2. Tablet vs Paper Productivity: Mode Comparison

To help compare the tablet and the paper forms more fairly, we wanted to compare only assignments that were conducted in the same mode, wave and time interval combinations. Out of 34 potential combinations, only 13 had both a tablet and paper assignments completed.

State	Mode	Wave	Interval	Tablet: Asgn count	Paper: Asgn count	Tablet: Int per asgn	Paper: Int per asgn	Tablet: Percent anglers intrcptd	Paper: Percent anglers intrcptd
RI	SH	4	B	5	5	3	4.8	88.2%	85.7%
RI	SH	5	B	4	3	1.3	1.7	62.5%	71.4%
RI	SH	5	C	11	9	4.5	3.8	80.3%	85.0%
RI	MB	4	B	12	7	2.3	0.7	28.3%	15.2%
RI	MB	4	C	4	7	3	2.7	100.0%	100.0%
RI	MB	5	B	17	10	0.5	1.9	100.0%	61.3%
RI	MB	5	C	14	12	1.5	2.3	72.4%	87.1%
SC	SH	4	C	6	2	4.3	4	39.4%	26.7%
SC	SH	6	B	7	2	0.9	4.5	66.7%	75.0%
SC	MB	4	B	9	6	3.7	13.8	47.1%	53.2%
SC	MB	5	P	11	3	0.9	4.3	40.0%	100.0%
SC	MB	5	B	30	6	3.6	6	18.6%	48.6%
SC	MB	6	P	21	3	0.5	4.7	28.6%	43.8%

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Table 3. Unique Assignment Combination Productivity

Again, many factors contribute to the ability of an interviewer to gain an intercept, but when normalizing for mode, wave and interval, we see that the tablet does very well at keeping pace with the paper forms. The tablet outperformed the paper forms in terms of PIC in Rhode Island and South Carolina on roughly 30% of assignment combinations. The tablet did struggle in mixed boat mode in some assignment combinations, but the paper forms did not do exceptionally well in those same sample cells. The tablet works very well in shore mode assignments because survey protocols dictate that shore mode anglers must be interviewed individually. If the survey were to be redesigned to a boat-based survey, rather than an individual angler survey, we believe the tablet would outperform the paper form in terms of productivity relative to PIC.

b. Cost

The cost of Android tablets has decreased significantly in the past few years and continues to decline. For this project we purchased Samsung Galaxy Tab 4's, a sturdy protective case and mobile charger all from Amazon.com. Table 4 outlines total cost for materials.

Equipment	Unit Price	Total Cost
10 Samsung Galaxy Tab 4	$165.00	$1,650.00
10 Unicorn Bettle PRO Case	$19.99	$199.90
10 Samsung Vehicle Charger	$13.33	$133.30
TOTAL		**$1,983.20**

Table 4. Upfront tablet costs

Field costs are fixed in both the tablet and paper studies because the interviewers must travel to the site(s) and conduct interviews over the full six-hour interval. Development/programming costs are also negligibly different for each survey method because there is comparable level of effort to produce a functional data entry system whether it is Android-based or PC-based. The true cost savings are recognized in the data entry costs.

Tablet data collection transferred the burden of data entry from the Raleigh, NC-based APAIS team to the interviewers in the field. The APAIS contract mandates a Service Contract Act (SCA) wage for hourly employees, which is set at $12.97 per hour for a Data Entry Operator in Wake County, NC. The average time to key a paper APAIS assignment was 15 minutes with high levels of variability depending on the number of intercepts collected. Knowing these inputs, we could calculate the cost-savings associated with the completed tablet assignments.

We recognized a cost savings of $651.74 over the four months of the pilot by completing 201 assignments on the tablet rather than manually keying the data. However, the tablet assignment quotas were less than the normal assignment quota for the main study. If the tablet were to be used in only Rhode Island and South Carolina to complete the main study, the upfront costs of the tablet would almost be recouped after just four months.

Keeping all other costs fixed, use of tablets to administer the APAIS between August and November in Rhode Island and South Carolina would save $1548.26. Rhode Island (756) and South Carolina (378) completed a total of 1,134 shore and mixed boat assignments in 2015; if all 1,134 assignments were completed on the tablet application, $3,677 would be saved in data entry costs easily covering the upfront hardware costs in the first year and earning an additional $1,693.80 in savings.

Reduction in printing costs would also be realized as tablets completely replace the need to print paper forms. During the pilot, 231 total assignments were completed comprising 945 intercepts. This translates to a total of $59.01 in savings of printing costs. While not a notable value for the pilot study, extrapolating to encompass the more than 50,000 intercepts and 7,000 assignments completed each year yields significant cost savings.

It should be noted that tablet costs have declined even further in the time since hardware was purchased for this project. The same tablets are now selling for $129.00 on Amazon.com, further reducing the upfront costs by $360 for the same 10 tablets. As technology continues to advance and becomes more affordable, the tablet solution will generate more and more savings to the APAIS project.

c. Timeliness

Faster availability of fisheries data is an additional priority addressed through electronic data collection. The pilot investigated improvement in data timeliness for data collected with the tablet versus paper forms. For the standard paper survey, it takes on average 17 days from assignment completion in the field until it is first keyed into the database. This delay is the result of many factors including staff-delayed shipping, transit delays, and processing procedures (i.e. assignments with intercepts are prioritized to be key entered first and single ASF's are keyed second). Data prioritization is essential to meet the project timeline of having all available biological data available for review on the 10th of the following month in Fishdump. Fishdump is a listing of all the raw fish data (species, counts, lengths, weights and dispositions) along with associated angler-trip attributes (gear, mode, available vs unavailable catch) to visually scan for obvious coding or key-entry errors prior to delivery of data to the NMFS. As expected, the tablet performed much better in terms of timeliness with a zero day average between assignment completion and data being transmitted into the database. There were initial programming costs associated with getting the data into the correct format from the Mobile FS data scheme to the APAIS database format, but once that process was established and tested, the data came in seamlessly.

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d. Errors

Error rates were very similar between the tablet assignments and paper assignments. We calculated the rate of INTCHCK (the APAIS error checking SAS program) errors between the two modes and found that they were relatively equal at about .02 errors per assignment. However, this error rate could be close to zero on the tablets with additional programming. After training sessions with the staff in Rhode Island and South Carolina, we immediately received feedback that they did not want any hard stops for invalid entries or range checks to confirm entry. Field staff were concerned that the tablet would already be slower than a paper form and they did not want any additional steps that would force them to stop and correct data in the middle of an interview. As such, we programmed the tablet with minimal range checks and allowed field staff to scroll back through all data prior to transmitting to RTI. Additional programming could allow more hard stops and on the fly validations once the staff were comfortable enough with the tablet and work flow.

e. Added Benefits

i. Photographs

One advantage of the tablet is the ability to capture photos of fish on the built in 3.0 megapixel camera and transmitting the photo with the assignment data. The photo allows quick confirmation of questionable species or lengths (if size reference included in photo). Currently, the best method for questioning species, lengths, and weights is during monthly data reviews and relies on sampler recall or individual initiatives to bring digital camera on field assignments.

Photo 1. Atlantic Mackerel from Rhode Island

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ii. GPS

Built in Global Positioning System (GPS) technology in the tablet recorded latitude and longitude while in the field to confirm location of samplers while on assignment. This was not an active GPS that allowed RTI staff to monitor the samplers' every movement, but a passive GPS that could be recorded when convenient for the sampler. The GPS capture screen appeared in each intercept as well as the Assignment Summary Form. Location data was particularly helpful when an invalid site error occurred in South Carolina. The sampler had accidentally entered the wrong site code for the assignment, producing an error when validating the data after he transmitted. The sampled had captured a GPS ping when he was on site and it was confirmed he was at the correct site by comparing the latitude and longitude data from the assignment to the Site Register data. This feature can also be used in background (admin controls only) to record positional data periodically during a pre-programmed period to document where and when the operator (interviewer) was entering interview data.

f. **Catch Estimates –** *This secondary goal resulted in more staff resources required than originally anticipated given the complexity of the MRIP estimation methodology and combinations with all other required components from effort surveys. Therefore, it was tabled indefinitely (as of this report this task was not completed). There is no reason to suspect the tablet entry of the APAIS interview responses would in any way influence the outcome of the estimates because the interview is identical to the paper form interview. The productivity and possibly biased samples used in this pilot study are more likely to result in 'different' cpue estimates than those produced from the full APAIS samples completed in both RI and SC during the pilot waves. See the discussion below of the tablet productivity vs the paper form productivity and possible reasons for the differences.*

5. Discussion

We feel that electronic data collection would be extremely beneficial to the APAIS project and should continue to be pursued for full implementation. The improvement in data timeliness is an incredible advantage of mobile data collection and a huge benefit for managers and scientists looking for more real time data from the recreational sector. Cost savings are quick to be realized even with upfront costs associated with hardware purchases. The ability to control and limit errors was not fully utilized in the pilot due to field concerns, but the potential to continually improve data quality still exists through the use of photos and GPS. This pilot project proves that the ability exists to transform the APAIS survey from a paper data collection instrument to a tablet based survey, and there are numerous benefits to be gained in doing so.

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The 17 day improvement associated with the tablet data being entered, transmitted, and compiled into a data base on a daily basis could be a game-changer for fisheries management and data review. Data being available for review on a weekly or even daily schedule could greatly improve in-season monitoring by allowing harvest estimates to be produced more frequently given some improvement in modeling or estimating effort to be associated with the catch-rate data. For true estimates to be produced in near-real time improvements to the entire suite of MRIP surveys would need to be made, but having the APAIS data available much more quickly is a great starting point.

Critique by RTI Team members:

The pilot project was not without its challenges. RTI did overcome obstacles and received helpful feedback from the field during the pilot. Below are a few of the challenges that occurred during the pilot, which should be considered in future development.

1. Version control in the field – Throughout the pilot, RTI was receiving feedback from the field about programming glitches or recommendations for improvements. For example, the type 2 catch grid was developed as a loop function that was not allowing samplers to get out of the grid. When RTI was made aware of the issue, we quickly developed a fix and rolled it out to the field through their next transmission. We made everyone aware of the update, provided instructions on how to install and asked for any feedback if it did not work. When we didn't hear any communication from the field, we assumed that the installation went as planned. That assumption turned out to be incorrect. We had samplers in the field that were frustrated because their install did not work properly and they continued to struggle with problems that should have been fixed with latest update. Once we found out that the updates were not installing correctly, we adjusted our installation instructions to include how to verify the correct version of the program was installed. That helped alleviate the issue of proper version control and we were able to quickly identify any samplers and tablets that needed direct support. Communication is essential to and from the field, and building a communication plan into the project schedule will help ensure success in future deployments.

2. Overcoming perceptions – Change is always difficult and an instrument change is especially difficult to implement in the survey world. The tablet was initially received very poorly by a few field members because it felt slow and eliminated many of the shortcuts they were able to utilize on the paper form. When doing field visits with the tablet, a sampler said, "[The tablet] makes me look stupid." The sampler was referring to the perception that the tablet was taking too long to complete an interview. Immediately after this, an intercept was completed in under a 60 seconds; however, there were no type 3 fish to weigh and measure. There was a perception in the field that the tablet was

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just not as efficient as the paper form, but we believe with a few procedural and instrument adjustments the negative attitude could be improved.

3. Productivity of Tablet vs Paper Form Interviewing - There are numerous factors that can help explain the apparent drop in production when the tablets were used to record interview responses. First, the assignment intervals were not kept constant with the paper study. The sample draws were produced step wise, meaning that the sample for the main paper study was produced first and then the tablet assignments were drawn from the remaining available sample cells. This method shifted numerous tablet assignments to less productive intervals (B/C) and day types (weekdays). The lack of peak interval weekend assignments helps explain the decline in intercepts per assignment. Second, when field samplers are interviewing groups of anglers off a single boat on the paper form, they often employ shortcuts to help maximize the number of intercepts collected. The most common shortcut observed in the field is recording multiple responses on a single form in available white space, and then transcribing those responses later on their own individual forms. Although this is not how the form was designed to be used, it is a common practice in the field. The tablet does not allow such shortcuts and forces the interviewer to go angler by angler to complete the intercept form. When intercepting large boat parties, the tablet often only produced one or two interviews, but the paper form often allowed interviewers to squeeze 5 or 6 interviews from a large fishing party. This also likely explains why the tablet appears to perform much worse in mixed boat mode assignments as compared to shore mode.

4. Fish slime – The largest drawback witnessed in the field was the ability to process a large cooler of fish in the type 3 catch grid quickly. Handling numerous fish one after another causes slime build up on the samplers hands and tablet. Even with constant toweling off and wiping, the tablet was very sensitive to the buildup of slime on the touch screen often causing taps and swipes to be unrecognizable. An assignment was observed when two angles returned to a ramp with a total of 100 fish in a cooler (50 fish per day limit). The sampler was able to get through about 10 total fish before the tablet started not recognizing taps and swipes causing sampler frustration. Normal survey procedures dictate that no more than 15 of each species per angler (30 total in this example) should be weighed and measured and all grouped catch should go on the first angler of the party. The sampler was unable to get to the 30 spot for this fishing party due to the quick buildup of slime on the tablet. Again, with further procedural and tablet adjustments, there may be a more efficient way to collect the type 3 data with minimal frustrations.

5. Computer Audio Recorded Interview (CARI) Technology – During the pilot, RTI distributed an update to the tablet that allowed samplers to record interviews with respondents. The respondents were made aware of the recording at the beginning of the interview and had the ability to decline the recording while still granting an interview. This

technology was met with extreme disdain from a few members of the field sampling team and production was not as high as we would have hoped. We are unable to directly link the lack of recorded interviews to a procedural issue or a general refusal from the recreational anglers. There could be public perception from the fishing community that the survey is not only invading on their recreational activity, but is doing so even more by now recording these conversations. Although explanatory language was added into the interviewing script that the recording was used for quality control purposes only, we believe there was general mistrust from the public regarding recorded interviews. This may be the level at which recreational anglers protect their information or it could just be reflective of the current level of trust citizens have with any perceived authority.

For the interviews that did transmit, most were extremely clear and we were able to clearly here the question being asked by the sampler and the response from the angler. This could be an extremely valuable quality control measure moving forward by allowing supervisors to remotely listen to how questions are being asked in the field and verifying that information with the transmitted data. Not all interviews were able to be heard clearly as wind seemed to muffle the microphone and completely mask the conversation between the sampler and angler on more than one occasion. Of the 17 audio recordings that were transmitted from the tablets, 14 came in with clear, understandable audio content. We believe that this tool can be successfully rolled out in the APAIS survey and would cut down on travel time and costs associated with field observations.

Critique by NMFS PI

Software – one overall objective was to develop software that could be used for Atlantic Coast states with the flexibility to be customized by state, if needed. The intercept form in this app is flexible to the extent that questions can be added/dropped or tailored to an individual state, or cluster of states, or all states. But the overall architecture of the app is not entirely as envisioned by the NMFS. The Case Management System is clearly an available survey structure RTI had in-house. Note the description of the software system by RTI staff (above, in Results): "RTI selected Mobile FS for the project as it was the most cost-effective and field-ready tool with respect to a budget that encompassed development, testing, data collection, and data management." From conversations with RTI staff there apparently was a disconnect with the system and software requirements during the project cost proposal preparation between project (survey) staff and the software development team that provided the cost estimate for software development. Once the project was approved and funded, when the programmers met with the project staff and specs were provided the programmers realized the requested software was more complex than they had originally understood but could not be completed within the funded budget. Therefore, the Mobile FS and CMS was adapted for use by the APAIS tablet pilot, which restricted several key attributes requested by NMFS. These were the easy transition among, or multiple angler interviews open, anglers within a boat party which would allow 'simultaneous' interviewing, a practice on paper forms common by making notes in the margins for other anglers who were in the same party as the interviewed angler, then transcribing onto forms later. Another shortcoming of this app is the lack of linkage between the ASF and Interviews. The Interviews can be started directly from 'case' identifier in the main menu, but should be a subset of

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the required ASF. Every assignment must have an ASF regardless of interviews obtained, or not. And, the ASF linkage should allow cross identification of site and times of interview(s), as well as prepopulating the date of the assignment to ensure the ASF and interviews are correctly referenced in the data files to be delivered to NMFS.   Although these are all software features that could be corrected in future versions, as RTI discussed above, the lack of inclusion in the field trial prevented field staff from testing the efficiency of a fully functioning app as originally intended.

6. Next steps

RTI believes the next appropriate step is to roll out the electronic data technology for full field implementation of the APAIS survey. With further adjustments to the instrument, the tablet can become even more streamlined and user friendly. One sampler said, "I wish the tablet would learn," meaning that customized lists of angler responses that allow faster data entry in the field would be well received. The benefits and cost savings greatly outweigh the upfront technology costs associated with the tablets. There was a limited budget to program the instrument and cover all field costs, but we believe with additional funding to improve the tablet program and address any survey procedural adjustments, this program could pave the way for electronic data capture from the recreational industry.

Although this application would be sufficient to implement tablet data entry in the field for the APAIS program, it would require upgrades to several key aspects to be as efficient at obtaining angler interviews from many or all anglers per boat party as paper forms allow. The slow, serial interviewing was an impediment to obtaining some interviews with anglers walking away rather than waiting 'their turn'. The lack of linking and sequential entry of ASF and angler interview is a data quality concern of NMFS, and in its present form that task can be accomplished post-entry, but as stated earlier in this report, if data can be verified or checked for errors in the field at point of entry, the quality would be superior, and any corrections could be made immediately and much more efficiently (less time, virtually no 'investigative' cost).

This pilot study did support the major objectives of developing an adequate software/hardware system suitable for use in APAIS field interviewing. It provided data in an extremely timely manner (possibly daily with daily transmission from field), was very cost effective in reducing manpower costs of data entry and reducing post-entry processing costs, provided seamless compilation of data from many interviewers once protocols programmed, and proved to stand up to typical field conditions without major problems of durability. The handling of fish and data entry continues to be time-consuming, but technology may soon provide digital measuring and weighing devices that transmit the output via Bluetooth to the tablet, thus eliminating the handling of fish and tablet sequentially.

The overall recommendation is to implement the use of an electronic tablet system as a tool for field data collection during angler interviewing. The tablets used are one model but there is no reason to suspect comparable hardware with similar attributes and capabilities would prove less hardy and useful. The software system needs improvements and given the interest in producing such apps, and those already available, or in development by cooperating

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contractors and agencies, suitable alternatives could be chosen for implementation. It is conceivable that multiple apps may be used along the coast provided each app output the data in a format that could easily be transcribed into a common database for delivery to NMFS and use in MRIP estimation of catch and effort statistics.

 We would like to thank the Rhode Island and South Carolina field samplers for their efforts during the survey and all the feedback they provided.

Electronic Data Collection for the Atlantic Access Point Angler Intercept Survey
RTI International and National Marine Fisheries Service

Executive Summary

The overall objectives of this pilot study were to develop and field test a software and hardware system for data collection on electronic tablets during angler interviewing in the Access Point Angler Intercept Survey (APAIS) and that goal was largely achieved. The results were somewhat mixed but generally positive in regards to feasibility of the system's use in the field, cost benefits of implementing the system coast-wide, and in quality of data obtained vs. data quality resulting from paper form data collection, manual key-entry of data, and post-entry data quality controls currently in place in the APAIS.

However, there were several issues raised by both field staff using the test platforms and by the NMFS Principal Investigator about the utility and operational aspects of the developed application. The functionality of interviewing several anglers within a boat party 'simultaneously' by switching among interviews, question by question, was a key attribute requested by field interviewers, but was not programmed into the app due to lack of flexibility in the software platform used. The logistic issues associated with handling fish (wet, slimy) and recording measurements continues to be a minor issue in handling and speed of interviewing. These impediments to rapid interview progress can deter anglers from interviewing and frequently led to some members of an angling party walking off, or refusing participation in the survey. These issues were not typical deterrents to interviewing using paper and pencil. However, overall, the tablet data entry system is a vast improvement for data collection in the field and with software modifications and modernizations should prove to be cost efficient and a great time-saver in data acquisition, processing, and quality.

The objectives of flexible software that can be customized as needed among the Atlantic States (and ultimately all states using APAIS data collection), tablets being a useful hardware platform for APAIS data entry, and both time-saving and cost efficient data processing have all been met in this pilot study. The minor improvements recommended are not out of expectations in modern computer-based systems that are frequently upgraded to take advantage of improvements in both software and hardware development. We recommend implementation of tablet data collection for conduct of the MRIP Access Point Angler Intercept Survey.

Update - In January 2019 the Atlantic Coast Cooperative Statistics Program (ACCSP) implemented a proprietary application installed on Android OS tablets to directly collect APAIS data in the field. The 8" tablets were protected by glare screens and water-resistant, shock-resistant cases and the hardware-software system had been field tested by all the Atlantic states, ME to GA, under the administration of the ACCSP's APAIS program (survey conduct was transferred on the Atlantic Coast from a contractor to a cooperative venture between the NMFS, ACCSP, and the Atlantic States' fisheries resource management agencies in Jan. 2016). Through the first year of use, the tablets have been durable (one broken, none failed) and the software has proven adaptable to requests for improvements in survey flow and questionnaire modifications. There are no 'subscription' fees to the developers who have been maintained on open-contract by ACCSP for this and other applications maintenance and development. Data transmittal and integrity has been flawless with the only problems traced to operator error. The Gulf of Mexico region's GulfFIN program procured funds to develop a similar application for their use, intend to use the same software developers, and implement tablet data collection for the APAIS in FL, AL, and MS in January 2021 pending successful testing of their new system in fall, 2020.

Background and Objectives

The National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS, NOAA Fisheries) recently approved a policy regarding the adoption of electronic technology solutions in fishery-dependent data collection programs. This policy states:

"*It is the policy of the National Oceanic & Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NOAA Fisheries) to encourage the consideration of electronic technologies to complement and/or improve existing fishery-dependent data collection programs to achieve the most cost-effective and sustainable approach that ensures alignment of management goals, funding sources and regulations*."

The policy requires each region, Alaska, Greater Atlantic, Pacific Islands, Southeast and Caribbean, and West Coast, to evaluate the application of electronic technologies to fisheries management within their areas of responsibility. Implementation of this objective requires contract support to oversee and facilitate this agency-wide effort in conjunction with the Regional Fishery Management Councils, Interstate Fishery Commissions, and other stakeholders.

Under contract with NOAA Fisheries, RTI International (RTI) conducted the paper and pencil interview (PAPI)-based Atlantic Access Point Angler Intercept Survey (APAIS) in the thirteen Atlantic coastal states north of Florida from 2012 through 2015. In 2014, RTI's contract expanded to include work in Puerto Rico; this work is ongoing. NOAA Fisheries also contracted with RTI to test the feasibility of electronic tablet-based data collection on the APAIS in the summer and fall of 2015. This work was designed to examine the benefits and challenges associated with operating in marine coastal environments. RTI managed the development, field testing, and implementation of data collection using Samsung Galaxy 4 tablets and RTI's Mobile Field Surveys (Mobile FS) software. The implementation was conducted in Rhode Island and South Carolina using APAIS staff who were familiar with the PAPI survey operation. The field test was conducted August 1st through November 30th, 2015, subsequent to development and field testing.

Objectives

1. Develop software that is adaptable for use in 15 states with flexible questionnaires suitable for use on a tablet.
2. Demonstrate that APAIS intercept survey data can be successfully collected using a tablet under typical field conditions.
3. Increase efficiency in the overall process of collecting and entering data, and evaluate cost savings by eliminating data forms, and hand-data entry staff or OCR hardware/software, while providing seamless integration of data into existing data processing algorithms and schedules.
4. Improve data accuracy via internal data limits and checks at point of entry and QC oversight of field interviewers' activity by automatically recording GPS locations, dates, and times of survey conduct.
5. Provide near real-time data access for survey data users.

A secondary goal of the project was to evaluate the impact of tablet use on productivity of the APAIS by comparing catch estimates generated from each method. This evaluation would take into account the catch composition of the samples, the productivity of interviews obtained per sampling assignment, and the variance of the catch estimates produced from the tablet samples vs the PAPI samples during the same wave. This goal required additional staff support from NMFS/ST1 outside the project team.

Methodology

RTI developed the electronic field survey using RTI Mobile FS, a powerful platform that allows users to conduct field studies on Android mobile devices. RTI Mobile FS is a suite of tools used to develop questionnaires for the iPAQ (Windows Mobile), Android and PC/Windows platforms. The suite includes tools for developing questionnaires, changing file formats, updating system options, and creating import files. The system also includes components for data management which allow a user to aggregate data, run reports, export data, and create SAS, SPSS, or Stata input statements for data collected with the system. The standard APAIS paper forms were replicated into the Mobile FS application using the same structure and language as it appears on the form.

RTI selected Mobile FS for the project as it was the most cost-effective and field-ready tool with respect to a budget that encompassed development, testing, data collection, and data management. The request from NMFS was a custom built application that would allow use of the APAIS interview in a similar appearance to the paper form (question followed by check boxes for response choices, or fields for character entry if open response or codes required) and the flexibility to switch among interviews without loss of partially completed interview data. Many 'off the rack' applications could develop the first requirement but the easy switch among partially completed forms was difficult to design and operate efficiently. That lesson was learned by the earlier trials of software/hardware by Macro International, a previous Atlantic Coast APAIS contractor.

Hardware

The Mobile FS APAIS Data Collection System was deployed on a Samsung Galaxy Tab 4 (Model SM-T230) tablet using Android Version 4.4.2. This device was selected due to its cost, size, weight and performance. The Tab 4 weighs only 1.4 pounds and has a 7-inch screen size, ideal for ease of handling for the duration of a six hour assignment. Ten (10) total tablets were purchased: four were deployed in each state, and two were retained by RTI for testing and troubleshooting. Protective covers were purchased to protect the device from environmental hazards and proved to be an ideal accessory for this purpose. The cover was a SUPCASE Unicorn Beetle PRO case (Model: SUP-GalaxyTab4-7-UBPRO-WHGY). These cases provided a high grade polycarbonate case for shock absorption, and a front cover with screen protector to prevent scratches while maintaining touch screen sensitivity. The cases were not water proof, but the dual layer design provided water resistance. No tablets were destroyed during the study due to water intrusion or damage from drops. Interviewers were also provided with a Samsung 2Amp

Micro-USB Vehicle Charger (Model: ECA-U21CBEBXAR) to enable mobile charging from their vehicle.

Software

Mobile FS is a native Android application and supports deployment to Android OS versions 4.0 and above. SQLite is used for data storage, and all survey related data is encrypted at rest and synchronized back to the private RTI network via a secure (HTTPS) communication channel.

RTI has developed and delivered the following components to the NMFS:

- All hardware purchased for the pilot project
- the ANDROID APAIS Mobile application installation file - APAIS.APK
- gats_survey0.db3 – database that houses the Assignment Summary Form Survey
- gats_survey1.db3 – database that houses the Intercept Form Survey
- gats_CMSDB.dbe – database that houses the application configuration and assignment data

The APAIS.APK is a binary executable that can be installed onto an ANDROID device by copying it to the device and executing. The db3 files can be accessed and manipulated with open source tools such as SQL Lite. New question and answer sets can be added to a survey by adding the information into the appropriate db3 file.

Software Architecture

Four major components were developed for the APAIS mobile application: the Case Management System (CMS), a two tiered main menu, Assignment Summary Form, and Intercept Form. Upon initiating the application on the tablet the main CMS screen appears along with informational items: system version, current date and time, and a password entry prompt for logging in. Note: the demo tablet/software includes a "Set Clock" button on this initial screen but if this is operational by field staff it could allow for editing of time by unscrupulous interviewers who arrive late but wish to code the data with the scheduled arrival time – this function should be removed and allow the device to capture the date/time from the service provider, GPS, or fixed by admin only.

The CMS provides the framework for the APAIS Mobile application to operate and is password protected via a Login button. In this application a single 'case' is an APAIS sampling assignment, identified by date, interval, mode, site(s) with state-specific control numbers (provided by the contractor; not the control7 produced by the NMFS assignment draw). Each case would then include a single Assignment Summary Form (ASF) and multiple interview forms (or none if no interviews were obtained.

Upon logging into the application, the case menu displays open assignments to the user. At this point the user has the ability to open the intercept form or the Assignment Summary Form for any of the available assignments to begin collecting data. The user can move between these two options within each assignment by returning to the Main Menu.

Case ID numbers are color-coded, allowing the user quick identification of opened cases. Several variables are preloaded from the assignment draw, including assignment date, mode, time interval (6 hour assignment interval), site numbers (single or two-site clusters), and control number. These variables are essential to help interviewers stay organized and working at correct times and locations. Submenus are also available from the main menu allowing the user to select various options; Action, Admin, and View.

The 'Action' option presents the user with a menu that provides the option to 'Transmit'. This action starts the secure wireless connection to the IFMS (Integrated Field Management System) at RTI and uploads all data collected while on assignment. The transmission process also downloads new assignments for the user and any available system updates. A confirmation message is displayed at the conclusion of the transmission process to confirm transmission was successful. If instrument updates are sent to the device by the IFMS, the CMS detects the update file and prompts the user to accept and proceed.

The 'View' option allows the user to sort the case menu by cases that are 'Pending' meaning the cases that have been started but have not been completed in the Assignment Summary Form. This aids the user in verifying the status of their assignments.

The 'Sort' option allows the user to sort their case menu by case ID, event code, assignment date, control number, or county. This feature allows the user to customize the case menu in the manner that is most useful to them and to minimize the time it takes to locate the desired case.

1. **Intercept Form**

The intercept form is accessed from the main menu. Each intercept has a predefined unique case ID. The user selects the desired intercept and the form opens with prefilled information from the draw such as intercept number, state code, county code, etc. The user is immediately prompted to start the GPS capture, and an automated satellite request is sent for a GPS location that is stored with the intercept.

Predefined list options are presented where possible, allowing the user to tap selections to expedite data entry.

Incremental seek options are provided to the user when the response requires an open entry (typed characters) such as the state and county of residence, or fish species targeted, caught (reported) or landed and examined. The user enters the first few characters, the associated entries fill a list, and the user selects and confirms the response choice.

When the user is weighing and measuring a fish, they are presented with the option to take a photo of the fish. The photo filename matches the case ID, and filenames update sequentially as additional photos are added.

Intercept skip logic was programmed into the application, meaning questions not to be asked due to the response of a previous question are not displayed. However, if the response to the

earlier question requires a subsequent question be asked, all the questions are displayed and a response is required to complete the interview. An example is the area fished questions: if area fished response is Ocean, then distance from Shore must be asked; if area fished is any of the Inland bodies (e.g. river, bay, specific estuary) the distance from shore choice is not displayed.

Additionally, a CARI (Computer Audio-Recorded Interview) feature was implemented in the final month of the pilot. This feature was discussed as a possible use of the hardware features, but was not specifically requested by the NMFS.

2. Assignment Summary Form

The Assignment Summary Form is also accessed from the main menu. As with the intercept form, data items such as control number, state code, county code, and mode are pre-loaded, negating the need to enter them and expediting the data entry process. Other items are programmed in defined lists, allowing the user to tap the appropriate choice and further reducing potential data key-entry errors.

3. Case Completion and Data Transmission

Numerous data validations are built into the logic to help users identify possible data entry errors and/or prevent incompatible responses to correlated questions, or invalid responses to any question. A simple example is the start and stop times for a site. The stop time must be after the start time. If it is not, an error message appears prompting the user to correct the entry.

When the user is ready to complete an assignment, they sign off by entering their interviewer ID into the last screen of the Assignment Summary Form. Once this is entered, the case is coded as complete and disappears from the Main Menu. The data is transmitted during the field interviewer's next transmission session.

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Field Assignments for Application Testing

NOAA Fisheries supplied the assignment sample draw on a monthly basis for the four months of field testing, August through November 2015. The pilot was conducted in Rhode Island with RTI managed field staff and in South Carolina with SC Department of Natural Resources staff. All staff members also conducted the standard APAIS study during the time period of the electronic tablet pilot. Field staff varied in age and technology aptitude offering a diverse group of opinions on the tablet functionality.

Assignments were drawn within a specific assignment mode per month targeting anglers only fishing from unique access points (SH = Shore, MB = Mixed Boat – Private, Rental and Charter boats). Below are the number of assignments drawn in each state by mode and month:

State	Month	Mode	
		Shore	Mixed-Boat
RI	Aug	7	16
	Sept	7	16
	Oct	8	15
	Nov	8	14
SC	Aug	7	20
	Sept	7	20
	Oct	7	21
	Nov	7	21
TOTAL		58	173

Table 1. Tablet Pilot Assignments

4. Results

RTI and NMFS analyzed the results of the tablet data collection for numerous metrics, including production, costs, timeliness, error rate, added benefits, and catch estimation. These five variables are discussed in detail below.

a. Production

To analyze the performance of the tablet in the field compared to the paper form we calculated Percent Intercepts Collected (PIC). We calculated PIC to help quantify whether the tablet was keeping pace with the paper forms in terms of total interviews collected as a proportion of total eligible anglers.

$$PIC = \frac{\text{Total Intercepts Collected}}{(\text{Total Intercepts Collected} + \text{Total Angler Counts})}$$

Total angler counts refers to all eligible anglers that were not interviewed during the six hour interval, including initial refusals, confirmed and unconfirmed trip counts, language barriers and key question refusals. Ineligible anglers (commercial, targeting shellfish, etc.) were not included in the Total Angler Counts variable.

The PIC was calculated based on mode and state. Overall, the tablet seems to struggle with collecting boat mode intercepts, but does relatively well with shore based anglers. We anticipated a drop in the mixed boat production, but did not expect such a dramatic decline for both Rhode Island and South Carolina.

State	Mode	Tablet: Asgn count	Paper: Asgn count	Tablet: Intercepts per asgn	Paper: Intercepts per asgn	Tablet: PIC	Paper: PIC
RI	SH	30	122	2.6	2.7	81.9%	84.6%
RI	MB	61	195	1.1	2.8	46.6%	81.3%
SC	SH	28	40	3.8	14.1	41.8%	56.2%
SC	MB	82	109	2.4	7.9	24.0%	53.8%

Table 2. Tablet vs Paper Productivity: Mode Comparison

To help compare the tablet and the paper forms more fairly, we wanted to compare only assignments that were conducted in the same mode, wave and time interval combinations. Out of 34 potential combinations, only 13 had both a tablet and paper assignments completed.

State	Mode	Wave	Interval	Tablet: Asgn count	Paper: Asgn count	Tablet: Int per asgn	Paper: Int per asgn	Tablet: Percent anglers intrcptd	Paper: Percent anglers intrcptd
RI	SH	4	B	5	5	3	4.8	88.2%	85.7%
RI	SH	5	B	4	3	1.3	1.7	62.5%	71.4%
RI	SH	5	C	11	9	4.5	3.8	80.3%	85.0%
RI	MB	4	B	12	7	2.3	0.7	28.3%	15.2%
RI	MB	4	C	4	7	3	2.7	100.0%	100.0%
RI	MB	5	B	17	10	0.5	1.9	100.0%	61.3%
RI	MB	5	C	14	12	1.5	2.3	72.4%	87.1%
SC	SH	4	C	6	2	4.3	4	39.4%	26.7%
SC	SH	6	B	7	2	0.9	4.5	66.7%	75.0%
SC	MB	4	B	9	6	3.7	13.8	47.1%	53.2%
SC	MB	5	P	11	3	0.9	4.3	40.0%	100.0%
SC	MB	5	B	30	6	3.6	6	18.6%	48.6%
SC	MB	6	P	21	3	0.5	4.7	28.6%	43.8%

Table 3. Unique Assignment Combination Productivity

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Again, many factors contribute to the ability of an interviewer to gain an intercept, but when normalizing for mode, wave and interval, we see that the tablet does very well at keeping pace with the paper forms. The tablet outperformed the paper forms in terms of PIC in Rhode Island and South Carolina on roughly 30% of assignment combinations. The tablet did struggle in mixed boat mode in some assignment combinations, but the paper forms did not do exceptionally well in those same sample cells. The tablet works very well in shore mode assignments because survey protocols dictate that shore mode anglers must be interviewed individually. If the survey were to be redesigned to a boat-based survey, rather than an individual angler survey, we believe the tablet would outperform the paper form in terms of productivity relative to PIC.

b. Cost

The cost of Android tablets has decreased significantly in the past few years and continues to decline. For this project we purchased Samsung Galaxy Tab 4's, a sturdy protective case and mobile charger all from Amazon.com. Table 4 outlines total cost for materials.

Equipment	Unit Price	Total Cost
10 Samsung Galaxy Tab 4	$165.00	$1,650.00
10 Unicorn Bettle PRO Case	$19.99	$199.90
10 Samsung Vehicle Charger	$13.33	$133.30
TOTAL		$1,983.20

Table 4. Upfront tablet costs

Field costs are fixed in both the tablet and paper studies because the interviewers must travel to the site(s) and conduct interviews over the full six-hour interval. Development/programming costs are also negligibly different for each survey method because there is comparable level of effort to produce a functional data entry system whether it is Android-based or PC-based. The true cost savings are recognized in the data entry costs.

Tablet data collection transferred the burden of data entry from the Raleigh, NC-based APAIS team to the interviewers in the field. The APAIS contract mandates a Service Contract Act (SCA) wage for hourly employees, which is set at $12.97 per hour for a Data Entry Operator in Wake County, NC. The average time to key a paper APAIS assignment was 15 minutes with high levels of variability depending on the number of intercepts collected. Knowing these inputs, we could calculate the cost-savings associated with the completed tablet assignments.

We recognized a cost savings of $651.74 over the four months of the pilot by completing 201 assignments on the tablet rather than manually keying the data. However, the tablet assignment quotas were less than the normal assignment quota for the main study. If the tablet were to be used in only Rhode Island and South Carolina to complete the main study, the upfront costs of the tablet would almost be recouped after just four months.

Keeping all other costs fixed, use of tablets to administer the APAIS between August and November in Rhode Island and South Carolina would save $1548.26. Rhode Island (756) and South Carolina (378) completed a total of 1,134 shore and mixed boat assignments in 2015; if all 1,134 assignments were completed on the tablet application, $3,677 would be saved in data entry costs easily covering the upfront hardware costs in the first year and earning an additional $1,693.80 in savings.

Reduction in printing costs would also be realized as tablets completely replace the need to print paper forms. During the pilot, 231 total assignments were completed comprising 945 intercepts. This translates to a total of $59.01 in savings of printing costs. While not a notable value for the pilot study, extrapolating to encompass the more than 50,000 intercepts and 7,000 assignments completed each year yields significant cost savings.

It should be noted that tablet costs have declined even further in the time since hardware was purchased for this project. The same tablets are now selling for $129.00 on Amazon.com, further reducing the upfront costs by $360 for the same 10 tablets. As technology continues to advance and becomes more affordable, the tablet solution will generate more and more savings to the APAIS project.

c. Timeliness

Faster availability of fisheries data is an additional priority addressed through electronic data collection. The pilot investigated improvement in data timeliness for data collected with the tablet versus paper forms. For the standard paper survey, it takes on average 17 days from assignment completion in the field until it is first keyed into the database. This delay is the result of many factors including staff-delayed shipping, transit delays, and processing procedures (i.e. assignments with intercepts are prioritized to be key entered first and single ASF's are keyed second). Data prioritization is essential to meet the project timeline of having all available biological data available for review on the 10th of the following month in Fishdump. Fishdump is a listing of all the raw fish data (species, counts, lengths, weights and dispositions) along with associated angler-trip attributes (gear, mode, available vs unavailable catch) to visually scan for obvious coding or key-entry errors prior to delivery of data to the NMFS. As expected, the tablet performed much better in terms of timeliness with a zero day average between assignment completion and data being transmitted into the database. There were initial programming costs associated with getting the data into the correct format from the Mobile FS data scheme to the APAIS database format, but once that process was established and tested, the data came in seamlessly.

d. Errors

Error rates were very similar between the tablet assignments and paper assignments. We calculated the rate of INTCHCK (the APAIS error checking SAS program) errors between the two modes and found that they were relatively equal at about .02 errors per assignment. However, this error rate could be close to zero on the tablets with additional programming. After training sessions with the staff in Rhode Island and South Carolina, we immediately received feedback

that they did not want any hard stops for invalid entries or range checks to confirm entry. Field staff were concerned that the tablet would already be slower than a paper form and they did not want any additional steps that would force them to stop and correct data in the middle of an interview. As such, we programmed the tablet with minimal range checks and allowed field staff to scroll back through all data prior to transmitting to RTI. Additional programming could allow more hard stops and on the fly validations once the staff were comfortable enough with the tablet and work flow.

e. Added Benefits

i. Photographs

One advantage of the tablet is the ability to capture photos of fish on the built in 3.0 megapixel camera and transmitting the photo with the assignment data. The photo allows quick confirmation of questionable species or lengths (if size reference included in photo). Currently, the best method for questioning species, lengths, and weights is during monthly data reviews and relies on sampler recall or individual initiatives to bring digital camera on field assignments.

Photo 1. Atlantic Mackerel from Rhode Island

ii. GPS

Built in Global Positioning System (GPS) technology in the tablet recorded latitude and longitude while in the field to confirm location of samplers while on assignment. This was not an active GPS that allowed RTI staff to monitor the samplers' every movement, but a passive GPS that could be recorded when convenient for the sampler. The GPS capture screen appeared in each intercept as well as the Assignment Summary Form. Location data was particularly helpful when

an invalid site error occurred in South Carolina. The sampler had accidentally entered the wrong site code for the assignment, producing an error when validating the data after he transmitted. The sampled had captured a GPS ping when he was on site and it was confirmed he was at the correct site by comparing the latitude and longitude data from the assignment to the Site Register data. This feature can also be used in background (admin controls only) to record positional data periodically during a pre-programmed period to document where and when the operator (interviewer) was entering interview data.

f.   **Catch Estimates –** *This secondary goal resulted in more staff resources required than originally anticipated given the complexity of the MRIP estimation methodology and combinations with all other required components from effort surveys. Therefore, it was tabled indefinitely (as of this report this task was not completed). There is no reason to suspect the tablet entry of the APAIS interview responses would in any way influence the outcome of the estimates because the interview is identical to the paper form interview. The productivity and possibly biased samples used in this pilot study are more likely to result in 'different' cpue estimates than those produced from the full APAIS samples completed in both RI and SC during the pilot waves. See the discussion below of the tablet productivity vs the paper form productivity and possible reasons for the differences.*

5. Discussion

We feel that electronic data collection would be extremely beneficial to the APAIS project and should continue to be pursued for full implementation. The improvement in data timeliness is an incredible advantage of mobile data collection and a huge benefit for managers and scientists looking for more real time data from the recreational sector. Cost savings are quick to be realized even with upfront costs associated with hardware purchases. The ability to control and limit errors was not fully utilized in the pilot due to field concerns, but the potential to continually improve data quality still exists through the use of photos and GPS. This pilot project proves that the ability exists to transform the APAIS survey from a paper data collection instrument to a tablet based survey, and there are numerous benefits to be gained in doing so.

The 17 day improvement associated with the tablet data being entered, transmitted, and compiled into a data base on a daily basis could be a game-changer for fisheries management and data review. Data being available for review on a weekly or even daily schedule could greatly improve in-season monitoring by allowing harvest estimates to be produced more frequently given some improvement in modeling or estimating effort to be associated with the catch-rate data. For true estimates to be produced in near-real time improvements to the entire suite of MRIP surveys would need to be made, but having the APAIS data available much more quickly is a great starting point.

"NMFS Project Report - RTI Tablet Pilot - Final Report - Updated Jan 2020", page 13

Critique by RTI Team members:

The pilot project was not without its challenges. RTI did overcome obstacles and received helpful feedback from the field during the pilot. Below are a few of the challenges that occurred during the pilot, which should be considered in future development.

1. Version control in the field – Throughout the pilot, RTI was receiving feedback from the field about programming glitches or recommendations for improvements. For example, the type 2 catch grid was developed as a loop function that was not allowing samplers to get out of the grid. When RTI was made aware of the issue, we quickly developed a fix and rolled it out to the field through their next transmission. We made everyone aware of the update, provided instructions on how to install and asked for any feedback if it did not work. When we didn't hear any communication from the field, we assumed that the installation went as planned. That assumption turned out to be incorrect. We had samplers in the field that were frustrated because their install did not work properly and they continued to struggle with problems that should have been fixed with latest update. Once we found out that the updates were not installing correctly, we adjusted our installation instructions to include how to verify the correct version of the program was installed. That helped alleviate the issue of proper version control and we were able to quickly identify any samplers and tablets that needed direct support. Communication is essential to and from the field, and building a communication plan into the project schedule will help ensure success in future deployments.

2. Overcoming perceptions – Change is always difficult and an instrument change is especially difficult to implement in the survey world. The tablet was initially received very poorly by a few field members because it felt slow and eliminated many of the shortcuts they were able to utilize on the paper form. When doing field visits with the tablet, a sampler said, "[The tablet] makes me look stupid." The sampler was referring to the perception that the tablet was taking too long to complete an interview. Immediately after this, an intercept was completed in under a 60 seconds; however, there were no type 3 fish to weigh and measure. There was a perception in the field that the tablet was just not as efficient as the paper form, but we believe with a few procedural and instrument adjustments the negative attitude could be improved.

3. Productivity of Tablet vs Paper Form Interviewing - There are numerous factors that can help explain the apparent drop in production when the tablets were used to record interview responses. First, the assignment intervals were not kept constant with the paper study. The sample draws were produced step wise, meaning that the sample for the main paper study was produced first and then the tablet assignments were drawn from the remaining available sample cells. This method shifted numerous tablet assignments to less productive intervals (B/C) and day types (weekdays). The lack of peak interval weekend assignments helps explain the decline in intercepts per assignment. Second, when field samplers are interviewing groups of anglers off a single boat on the

paper form, they often employ shortcuts to help maximize the number of intercepts collected. The most common shortcut observed in the field is recording multiple responses on a single form in available white space, and then transcribing those responses later on their own individual forms. Although this is not how the form was designed to be used, it is a common practice in the field. The tablet does not allow such shortcuts and forces the interviewer to go angler by angler to complete the intercept form. When intercepting large boat parties, the tablet often only produced one or two interviews, but the paper form often allowed interviewers to squeeze 5 or 6 interviews from a large fishing party. This also likely explains why the tablet appears to perform much worse in mixed boat mode assignments as compared to shore mode.

4. Fish slime – The largest drawback witnessed in the field was the ability to process a large cooler of fish in the type 3 catch grid quickly. Handling numerous fish one after another causes slime build up on the samplers hands and tablet. Even with constant toweling off and wiping, the tablet was very sensitive to the buildup of slime on the touch screen often causing taps and swipes to be unrecognizable. An assignment was observed when two angles returned to a ramp with a total of 100 fish in a cooler (50 fish per day limit). The sampler was able to get through about 10 total fish before the tablet started not recognizing taps and swipes causing sampler frustration. Normal survey procedures dictate that no more than 15 of each species per angler (30 total in this example) should be weighed and measured and all grouped catch should go on the first angler of the party. The sampler was unable to get to the 30 spot for this fishing party due to the quick buildup of slime on the tablet. Again, with further procedural and tablet adjustments, there may be a more efficient way to collect the type 3 data with minimal frustrations.

5. Computer Audio Recorded Interview (CARI) Technology – During the pilot, RTI distributed an update to the tablet that allowed samplers to record interviews with respondents. The respondents were made aware of the recording at the beginning of the interview and had the ability to decline the recording while still granting an interview. This technology was met with extreme disdain from a few members of the field sampling team and production was not as high as we would have hoped. We are unable to directly link the lack of recorded interviews to a procedural issue or a general refusal from the recreational anglers. There could be public perception from the fishing community that the survey is not only invading on their recreational activity, but is doing so even more by now recording these conversations. Although explanatory language was added into the interviewing script that the recording was used for quality control purposes only, we believe there was general mistrust from the public regarding recorded interviews. This may be the level at which recreational anglers protect their information or it could just be reflective of the current level of trust citizens have with any perceived authority.

For the interviews that did transmit, most were extremely clear and we were able to clearly here the question being asked by the sampler and the response from the angler.

This could be an extremely valuable quality control measure moving forward by allowing supervisors to remotely listen to how questions are being asked in the field and verifying that information with the transmitted data. Not all interviews were able to be heard clearly as wind seemed to muffle the microphone and completely mask the conversation between the sampler and angler on more than one occasion. Of the 17 audio recordings that were transmitted from the tablets, 14 came in with clear, understandable audio content. We believe that this tool can be successfully rolled out in the APAIS survey and would cut down on travel time and costs associated with field observations.

Critique by NMFS PI

Software – one overall objective was to develop software that could be used for Atlantic Coast states with the flexibility to be customized by state, if needed. The intercept form in this app is flexible to the extent that questions can be added/dropped or tailored to an individual state, or cluster of states, or all states. But the overall architecture of the app is not entirely as envisioned by the NMFS. The Case Management System is clearly an available survey structure RTI had in-house. Note the description of the software system by RTI staff (above, in Results): "RTI selected Mobile FS for the project as it was the most cost-effective and field-ready tool with respect to a budget that encompassed development, testing, data collection, and data management." From conversations with RTI staff there apparently was a disconnect with the system and software requirements during the project cost proposal preparation between project (survey) staff and the software development team that provided the cost estimate for software development. Once the project was approved and funded, when the programmers met with the project staff and specs were provided the programmers realized the requested software was more complex than they had originally understood but could not be completed within the funded budget. Therefore, the Mobile FS and CMS was adapted for use by the APAIS tablet pilot, which restricted several key attributes requested by NMFS. These were the easy transition among, or multiple angler interviews open, anglers within a boat party which would allow 'simultaneous' interviewing, a practice on paper forms common by making notes in the margins for other anglers who were in the same party as the interviewed angler, then transcribing onto forms later. Another shortcoming of this app is the lack of linkage between the ASF and Interviews. The Interviews can be started directly from 'case' identifier in the main menu, but should be a subset of the required ASF. Every assignment must have an ASF regardless of interviews obtained, or not. And, the ASF linkage should allow cross identification of site and times of interview(s), as well as prepopulating the date of the assignment to ensure the ASF and interviews are correctly referenced in the data files to be delivered to NMFS.   Although these are all software features that could be corrected in future versions, as RTI discussed above, the lack of inclusion in the field trial prevented field staff from testing the efficiency of a fully functioning app as originally intended.

6. Next steps

RTI believes the next appropriate step is to roll out the electronic data technology for full field implementation of the APAIS survey. With further adjustments to the instrument, the tablet can become even more streamlined and user friendly. One sampler said, "I wish the tablet would learn," meaning that customized lists of angler responses that allow faster data entry in the field would be well received. The benefits and cost savings greatly outweigh the upfront technology costs associated with the tablets. There was a limited budget to program the instrument and cover all field costs, but we believe with additional funding to improve the tablet program and

address any survey procedural adjustments, this program could pave the way for electronic data capture from the recreational industry.

Although this application would be sufficient to implement tablet data entry in the field for the APAIS program, it would require upgrades to several key aspects to be as efficient at obtaining angler interviews from many or all anglers per boat party as paper forms allow. The slow, serial interviewing was an impediment to obtaining some interviews with anglers walking away rather than waiting 'their turn'. The lack of linking and sequential entry of ASF and angler interview is a data quality concern of NMFS, and in its present form that task can be accomplished post-entry, but as stated earlier in this report, if data can be verified or checked for errors in the field at point of entry, the quality would be superior, and any corrections could be made immediately and much more efficiently (less time, virtually no 'investigative' cost).

This pilot study did support the major objectives of developing an adequate software/hardware system suitable for use in APAIS field interviewing. It provided data in an extremely timely manner (possibly daily with daily transmission from field), was very cost effective in reducing manpower costs of data entry and reducing post-entry processing costs, provided seamless compilation of data from many interviewers once protocols programmed, and proved to stand up to typical field conditions without major problems of durability. The handling of fish and data entry continues to be time-consuming, but technology may soon provide digital measuring and weighing devices that transmit the output via Bluetooth to the tablet, thus eliminating the handling of fish and tablet sequentially.

The overall recommendation is to implement the use of an electronic tablet system as a tool for field data collection during angler interviewing. The tablets used are one model but there is no reason to suspect comparable hardware with similar attributes and capabilities would prove less hardy and useful. The software system needs improvements and given the interest in producing such apps, and those already available, or in development by cooperating contractors and agencies, suitable alternatives could be chosen for implementation. It is conceivable that multiple apps may be used along the coast provided each app output the data in a format that could easily be transcribed into a common database for delivery to NMFS and use in MRIP estimation of catch and effort statistics.

We would like to thank the Rhode Island and South Carolina field samplers for their efforts during the survey and all the feedback they provided.